ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXVI., No 23.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 377
Masonry Viaduct over Kinnickinnick Creek, Chesapeake & Ohio Ry. (illustrated)..... 378
The Latest American Battleships (with inset)..... 378
Two-Cylinder Compound Locomotive; Austrian State Railways (illustrated)..... 379
Friction Horse-Power in Factories..... 379
A Novel French Highway Bridge (illustrated)..... 380
Progress in the Manufacture of Iron and Steel in America..... 381
Trial of Steam Jackets on a Locomotive Engine.... 383
The Niagara Falls & Buffalo Electric Power Transmission 389
Annual Meeting of the American Society of Mechanical Engineers 391
EDITORIAL NOTES 384
A Test of Steam Jackets on a Locomotive—The Latest Water Supply Award in Jersey City—Motor Carriages and Company Promoters in England—The Latest Scheme for the Philadelphia Water Supply.
EDITORIAL.
A Notable Departure in Macadam Road Construction (illustrated)..... 385
LETTERS TO THE EDITOR.....385-388
Corrections for Vertical Curves—Concerning Skew Arches—Moment Tables for Cooper's Specifications—The Accident to the Painters' Scaffold on the Brooklyn Bridge Station—The Advantages of a Tunnel for the Newtown Creek Crossing—Proposed Standard Specification for Portland Cement.

THE JERSEY CITY WATER CONTRACT has been awarded to the East Jersey Water Co. by the Board of Street and Water Commissioners. The Board of Finance must concur in the award and the Mayor must approve it, after which it must be executed and signed. The accepted proposal is for a gravity supply from the Rockaway River, to be delivered at the present high service reservoirs in Jersey City, 210 ft. above the tide, through a single pipe line with a daily carrying capacity of 50,000,000 gallons. Storage will be provided to ensure a daily supply of 35,000,000 gallons at the start, with an increase at any time to 50,000,000 gallons, on three years' notice from the city. The city agrees to take at least 20,000,000 gallons of water per day, and 30,000,000 gallons in case it orders the works increased to a capacity of 50,000,000 gallons. The prices by the million gallons, are $35 for the first 20,000,000; $36 for all between 20,000,000 and 30,000,000; $35 for between 30,000,000 and 40,000,000; and $34 for between 40,000,000 and 50,000,000 gallons. This curious sliding scale, with its upward and downward turn, results in an average price of $35 per 1,000,000 gallons when the full contract quantity is reached, and makes the average cost for all water between 20,000,000 and 40,000,000 gallons per day greater than the first 20,000,000 gallons. The city has the option of buying the plant at the end of 5, 10 or 15 years for $6,990,000. The other bids, submitted both by the East Jersey Water Co. and its only competitor, the Rockaway & Hudson Water Co., were given in our issue of Aug. 27, 1896. Legal proceedings to upset the award are already promised, in case the other authorities concur with the Street and Water Commissioners. Editorial comment on this subject is made elsewhere in this issue.

THE NEW DRIVEN WELL WATER SUPPLY for Brooklyn is said to fall short by about 2,000,000 or 3,000,000 gallons of the 25,000,000 gallons called for by the contract with Edwards, Monohan, Miller & Edwards. No official information is at hand. All possible capital is being made of the above report by those who wish the city to take steps to secure water outside of Long Island. Some of the expressions of opinion are doubtless due to real concern for the city, but others bear the stamp of the ceaseless agitation of some months past, in the apparent interest of private parties who wish to sell the city distant water or water rights.

THE DU BOIS, PA., RESERVOIR, now under construction for the water supply of that town, is located on the Juniata River, very close to the limits of the watershed. The reservoir is made by building an earth and rock-faced dam, 150 ft. long, across a ravine, the reservoir covering about one acre and having a capacity of 3,000,000 gallons. But to obtain more water than the Juniata at this point affords, a tunnel is being driven 1,542 ft. through the dividing ridge to the streams heading on the other side. In this manner water will be obtained from the upper Juniata Narrows Creek and by Wolf Creek. The engineer is Mr. H. S. McMinn, and the reservoir is being built by Mr. John E. Du Bois, who owns all the land covered by this watershed.

THE REMOVAL OF SNOW from the streets of New York during this winter will probably be done by Mr. G. M. Furman, of 1 Broadway, Col. Geo. E. Waring, Jr., M. Inst. C. E., having recommended the award of the contract to Mr. Furman. The price will be 42 cts. per cu. yd., against 56 cts. paid last year.

THE ANNUAL TRACK INSPECTION on the Columbus, Hocking Valley & Toledo Ry., shows that the general average condition of the track has advanced from an average marking of 78.2% to 80.4%. The report issued to the supervisors, foremen and section men states that there has been a marked improvement in the condition of switches and frogs, and the leads connecting them, but that there is a tendency to neglect the condition of the sidings. The premiums are awarded for the greatest improvement resulting from the labors of trackmen during the year. The company is responsible for the quantity and quality of materials furnished, and those who have made the best use of such materials are entitled to the most credit. The report is issued by Mr. F. B. Sheldon, Chief Engineer, and Mr. Wm. Michel, Engineer of Maintenance of Way.

A DOUBLE DECK TUNNEL is the project of the Metropolitan District Ry., of London, for facilitating traffic on its underground line in that city. The present underground line has a double track, and it is proposed to build two single track tunnels at some distance below this line, to be used for express trains, there being only one station between the terminus and the point where the low-level line will rise to the grade of the existing line.

THE BOSTON TERMINAL CO. is making good progress with the acquisition of land and the preparation of plans for its great terminal station at Summer St. and Atlantic Ave., Boston, Mass. The station and yards will occupy about 40 acres, and 30 acres have already been purchased and paid for. This station will take the place of the present Park Square and Kneeland St. terminals of the New York, New Haven & Hartford R. R., and the Kneeland St. terminal of the Boston & Albany R. R. Special attention is being given to secure a prompt and easy handling of the very heavy suburban traffic. Mr. Geo. B. Francis, M. Am. Soc. C. E., is the engineer.

A RAILWAY TERMINAL on a large scale at Washington, D. C., is proposed for the joint use of the Pennsylvania R. R., Chesapeake & Ohio Ry. and Southern Ry. The plans will include a large union station with depressed approaches, and extensive freight yards.

PLANS FOR RAILWAY TERMINALS at Christiania, Norway, are invited by the government, and prizes of $2,500, $1,000, $500 and $250 are offered for the best plans submitted in competition. Further information may be obtained on application to the Railway Office of the Department of Public Works, 6 Victoria Terrace, Christiania, Norway. Plans must be sent in by March 31, 1897.

100-LB. RAILS are being used quite extensively on the Chesapeake & Ohio Ry. With a recent order of 1,000 tons of these rails, now being laid, this company will have 45 miles of track laid with 100-lb. rails, all on the Huntington Division. About 1,800 tons of these rails are in lengths of 60 ft.

A DOUBLE-END TANK LOCOMOTIVE has been built by the Brooks Locomotive Works, Dunkirk, N. Y., for service in Japan. It is for a gage of 3 ft. 6 ins., and has six driving wheels and leading and trailing pony trucks. The tanks are at each side of the boiler, and there is a completely enclosed cab and a rear coal bunker. The leading dimensions are as follows:

Driving wheels, diameter		4 ft. 0 ins.
Cylinders		15 × 22 ins.
Boiler, diameter		4 ft. 6 ins.
Firebox		6 ft. 6 ins. × 2 ft. 5 ins.
Heating surface,	tubes	895 sq. ft.
" "	firebox	83 " "
" "	total	978 " "

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision Dec. 7 on the Baltimore & Ohio Southwestern Ry. at Sodamsville, O. An inspection train carrying officers of the road ran into an accommodation train, three persons being killed and eight injured. The accident is said to have been caused by a misunderstanding of orders on the part of the crew of the special train.——A freight train on the Gulf, Colorado & Santa Fe R. R. ran into an open switch at a gravel pit near Justin, Ind. Ter., Dec. 4. Three men were killed.

A COAL YARD FIRE occurred Dec. 1 at the Charlestown yards of the Boston & Maine R. R., and the coaling station and about 10,000 tons of coal were destroyed. A fire had been smouldering in the coal pile for some days, and the men had been at work trying to reach it, but it broke out suddenly, and it was then too late for the fire department to do much good. Traffic was blocked for several hours.

ANOTHER SERIOUS FLOOD in the Pacific northwest has again caused extensive damage to railways and serious interference with traffic. In Washington the greatest damage has been done, bridges and banks having been washed out on the Great Northern Ry. and Northern Pacific R. R.——Severe floods have been caused near Chippewa Falls, Wis., by a heavy jam of ice and logs in the river.

GOVERNMENT AID TO RAILWAYS in Canada has been pretty expensive, according to the "Canadian Magazine." On June 30, 1895, there were 16,031 miles of track laid in Canada, and the Dominion Government has contributed to this at the rate of $9,369 per mile constructed, the Provincial Government at the rate of $1,847 and the municipalities at the rate of $81 per mile. That is, for the net result of 16,091 miles, Canada has contributed about $195,000,000. In Cape Colony the proportion of net revenue to capital cost of railways is 5.75%; in India, 4.96%; in South Australia, 3.13%; in New South Wales, 3.46%; in New Zealand, 2.73%; in Queensland, 2.13%, and in Canada, 1.57%. In only one British colony is the proportion lower than in Canada, and that is Tasmania. The "Magazine" thinks that this seems to indicate that Canada is building railways too fast.

ELECTRIC TRACTION is contemplated for the suburban and branch lines of the New York, New Haven & Hartford R. R. According to a published statement by Mr. C. F. Clark, the President, the general policy of the road relative to the introduction of electricity as a motive power may be given as follows: Electricity as a motive power is foreshadowed in the last annual statement of the road. On the South Shore branch of the Old Colony system, the current has been successfully and economically conveyed in a third rail, insulated upon wooden blocks in the center of each track. The results have surprised experts, and it is now probable that a third rail will be laid at various points upon the company's property during the year to come. Short branches to the centers of business and population may then be constructed from the company's lines.

AN ELECTRIC RACK-RAILWAY to the top of the Jungfrau, in Switzerland, is proposed. The line would be 7½ miles long, starting at Scheidegg, and of this distance about 6 miles would be in tunnel. Grades of 25% are proposed and on the Eiger, the Mouch and other points will be stations selected with regard to scenic features. The maximum speed on grades of 15% and more will be 5 miles per hour, and 5 to 6 miles on other parts. At the foot of the main peak of the Jungfrau an inclined elevator shaft would be operated by electricity, with a lift of 330 ft., leading to the very summit. The estimated cost is $2,000,000, and the project is the outcome of the engineering and financial success of the Mont Saleve electric road, near Geneva. The cars would be lighted and heated by electricity, the latter provision being especially necessary as the average temperature in the tunnel is estimated at 2° to 3° below zero C., to the Mouch, and at from 6° to 10° below from that point to the Jungfrau.

THE ERIE CANAL SEASON OF 1896 lasted seven months. The Collector of the Port of Buffalo says that while the showing of traffic is decidedly superior to that of 1895, it can not be said to be satisfactory. The shipments of grain from Buffalo aggregated 35,868,966 bushels, an increase of nearly 16,000,000 over the preceding year, but nearly 13,000,000 bushels less than the record for 1894. But the grain receipts by the lake at Buffalo for this season are the largest on record, aggregating 154,338,921 bushels, for 1896, exceeding the receipts of 1895 by 51,000,000 and those of 1894 by 57,500,000 bushels. The previous largest record was 132,808,234 bushels in 1893.

A NEW SYSTEM OF VENTILATION has been put in use in the U. S. Senate chamber at Washington, designed by Prof. S. H. Woodridge, of the Massachusetts Institute of Technology. The benches in the visitors' gallery have been removed and theater chairs, with folding seats, substituted. The legs of the chairs are hollow, with perforated sides, and the fresh air for ventilation is distributed through the perforations. The air is furnished by a fan driven by an electric motor, and in warm weather it is first cooled to 60° by an ammonia refrigerating apparatus, depositing its moisture, and is then dried and heated to 70° or 75° by passing over hot water pipes. In cold weather the refrigerating apparatus is omitted and the air is warmed to the desired temperature.

CIVIL SERVICE EXAMINATIONS will be held by the New York Civil Service Commission as follows: Dec. 17, building inspectors of masonry; Dec. 18, inspectors of pier building. Particulars may be obtained from Mr. S. William Briscoe, secretary to the commission, New Criminal Court Building. The Civil Service Commission of Brooklyn, N. Y., is receiving applications for the following positions: Expert civil engineer, chief examiner of plans, expert for steel and iron construction, engineer of sewage purification, superintendent of sewer and water pumping station, inspector of construction of buildings, and inspector of sewers.

MASONRY VIADUCT OVER KINNICKINNICK CREEK; CHESAPEAKE & OHIO RY.

The accompanying illustration shows part of a five-arch masonry railway viaduct built over the Kinnickinnick Creek on the line of the Chesapeake & Ohio Ry., in southeastern Kentucky. This bridge was originally built, in 1856, under the direction of Col. Childs, for the Maysville & Big Sandy Ry. Co. The builder was a Cincinnati contractor, who also constructed the arch culvert over Briary Creek, at Quincy. The railway company failed when the bridge was only partially completed, the arches being sprung and the spandrel filling in place. As the work was not in a condition to stand the weather, Col. Childs, at his own expense, put on enough of the upper courses to preserve the masonry, and the bridge stood in this condition for a number of years. The country people in the neighborhood, sometime in the "60's," built a wooden approach at each end of the viaduct and used the structure as a highway bridge. In 1886 the Chesapeake & Ohio Ry. extended its line to Cincinnati, under Col. Childs as Chief Engineer, and buying out the old charter this company completed the bridge.

Masonry Viaduct Over Kinnickinnick Creeek, Ky., Chesapeake & Ohio Ry.

The viaduct has five full-center arches of about 50-ft. span each, with a width of 8 ft. at the piers, and racked out to a finished width of 12 ft. above by means of projecting courses. The bridge carries a single line of rails with inside iron guard rails. The work is in excellent condition, without a crack in the masonry or a spawled joint and is a fitting monument to the skill of the designer and to the honest work of the contractor.

It is worth noting that the failure of the railway company of 1856 to pay for this masonry caused the financial ruin of this honest contractor. The Chesapeake & Ohio Ry. Co., after coming into possession, 30 years after, sought out the widow of this man and paid in full this old debt. For the view and the interesting notes accompanying it we are indebted to Mr. S. P. Baird, of Portsmouth, Ohio.

THE LATEST AMERICAN BATTLESHIPS.

(With inset.)

At the recent fourth annual meeting of the Society of Naval Architects and Marine Engineers Mr. Philip Hichborn, Chief Constructor, U. S. N., described the special features of the "Alabama" class, the most recently designed of the battleships of our new navy. These features are briefly set forth as follows:

The shallowness of our harbors is one of the first and chief difficulties met with by our naval architects; imposing as it does limitations and restrictions which greatly complicate the general design where so many other elements have to be considered. But the success attained in this direction is quite satisfactory, and in these new battleships the draft is only 23 ft. 6 ins. at their normal displacement, with all outfits and two-thirds supply of stores, ammunition, etc., on board, and 800 tons of coal in the bunkers.

The freeboard forward is increased, as contributing not only to the sea-going qualities of the vessel, but as also giving additional berthing space in the forecastle deck provided, and this increase in height lifts the axis of the forward turret guns and enables them to be worked in almost any weather. In the matter of speed, our designers believe that it is not desirable, in battleships, to sacrifice other and essential qualities to obtain the high speed aimed at in some foreign navies. The highest speed heretofore adopted in fleet tactics with these vessels does not exceed 12 knots; while the "Alabama" class is designed for 16 knots, thus still greatly exceeding the speed called for in the actual operations of war. On the other hand, the contract speed required in our new ships must be steadily maintained for four hours, and is not a mere measured mile record such as is demanded for foreign ships.

The framing of the new battleships differs slightly from that in vogue in other vessels of this class in our navy. The main frames are continuous from the keel to the armor shelf, and again from the armor shelf to the deck. The longitudinals are, of course, continuous, their lower edges being scored over the main frame angles and the lower angles of the longitudinals being worked intercostally. The upper angles of the longitudinals, however, are continuous while the reverse bars are worked intercostally. Between the frame angles and the reverse bars are worked bracket-plates of uniform width, flanged at one end so as to connect with the longitudinals, and also flanged at the other end to give local stiffness. In this manner great rigidity is given to the floors, and there is less liability to damage in grounding or in docking. The flanged floor plate provides greater strength with less weight. Docking keels are provided, and the bilge keels are narrowed down to nothing as they approach the midship section, thus forming no obstruction in passing the gateway of the dry docks. The continuous bilge keel would be preferred for increased resistance to rolling and diminished resistance to progress through the water; but dry-docks impose limitations in this direction, and the plan adopted is a compromise.

In the arrangement of coal-bunkers especial care has been taken to provide easy storage and accessibility for firing, while affording good protection for the boilers. A distinct departure is made in setting the boilers athwartships instead of fore and aft, as in former practice. The advantages of the new arrangement are the increased and excellent facilities for firing and easy communication between the fire-rooms.

The hull is protected against injury at the water line by heavy tapering armor of a maximum thickness of 16½ ins., extending from 3 ft. 6 ins. above to 4 ft. below the normal load water-line. The maximum thickness covers the entire length of the engine and boiler spaces; from the forward cross coal-bunker bulkhead the thickness is gradually reduced to 4 ins., and this thickness is maintained to the bow. At the top of the armor belt, and covering the engine and boiler spaces, is a flat protective deck, 2¾ ins. thick, worked in three layers and extending from side to side of the ship. This deck is tap-riveted to the upper edge of the side armor. Forward of the machinery space, however, the protective deck is turned down to the armor shelf level, so that any projectile passing through the vertical armor would have to encounter a sloping deck 3 ins. thick. Aft of the armor-belt the protection deck is inclined in a similar manner, except that this deck is 4 ins. thick to better protect the steering gear. Where this protective deck is inclined at the sides, coffer-dams are provided, 3 ft. wide, and extending to the top of the armorbelt, and packed with corn-pith cellulose compressed to a density of 8 lbs. per cubic foot. To meet a raking fore or aft fire, and to protect the boilers and engines, the opening between the flat deck and the sloping sides is closed at each end by diagonal armor bulkheads, 12 ins. thick.

From the top of the thick belt, extending to the main deck, the hull is further protected by a belt of 5½-in. armor, extending from barbette to barbette, and ending in diagonal bulkheads on a line with the 12-in. armor below. Within the limits of this belt the broadside torpedo tubes are placed. Inboard of this 5½-in. armor, and extending well forward and aft, are other corn-pith cellulose coffer-dams, 3 ft. high by 3 ft. wide, with the top of these dams 6½ ft. above the load water-line. Between the main and upper decks, and from the forward barbette to a point just forward of the after turret, the side of this ship is protected by 5½-in. armor, with diagonal armor terminations. Within the armor are placed eight of the 6-in. rapid-fire guns. The central part of the ship is thus completely enclosed in a continuous wall of armor, extending from 4 ft. below load water-line to the level of the upper deck, about 23 ft. in all, with the walls nowhere less than 5½ ins. thick. As additional security, 1½-in. splinter bulkheads are placed between each pair of 6-in. guns; and the other 6-in. guns on the gun deck forward and on the upper deck amidships are protected by special armor 6 ins. thick and curved to protect against a raking fire. The conning tower is protected by 10-in. armor, and it is connected with a central station below the protective deck by a tube with walls 7 ins. thick. In addition to the forward conning tower there is a signal tower at the after end of the superstructure deck, with walls 6 ins. thick.

In the character and arrangement of the battery decided changes have been made. The 8-in. battery has been entirely abandoned and only two calibers of heavy guns are used, 13-in. and 6-in. The special board on battery arrangement, to which this question was submitted, decided that the use of an intermediate caliber was unnecessary and complicated the arrangement for ammunition supply, and the arrangement adopted is in line with recent foreign practice. The main battery includes four 13-in. guns, mounted in pairs in forward and aft turrets placed on the midship line, and protected by 15-in. armor with 17-in. port-plates. The ammunition hoists and revolving gear for the turrets are protected by barbettes 15 ins. thick, except over the arc within the diagonal armor, where it is reduced to 10 ins. to save weight. The turrets are oval in shape, with the front plates slightly inclined, and the rear plates vertical to give more room for loading. The center of gravity of the turret is in the axis of rotation, so that the turret is balanced and can be turned without serious retardation when the ship has a heavy list.

The forward turret is at the level of the forecastle deck with the axis of the guns 26 ft. 6 ins. above the normal load water-line. The after

Comparison of the Latest Battleships of the Principal Naval Powers.

Name of vessel	Nation. United States. "Alabama."	England. "New Renown."	France. "St. Louis."	Germany. "Ersatz Preussen."	Russia. "Oslabya."	Italy. "St. Bon."
Length	368 ft.	390 ft.	385 ft.	397 ft.	402 ft.	344½ ft.
Beam	72 "	74 "	66½"	66.93"	70½"	(9½"
Mean draft	23 ft. 6 ins.	25 ft. 5 ins.	25 ft. 11 ins.	25 ft. 9 ins.	26 ft.	24 ft. 9 ins.
Displacement, tons	11,500	12,900	11,.275	11,130	12,674	9,800
Indicated horse-power	10,000	15,000	14,500	13,000	14,500	13,500
Speed	16 knots.	18¾ knots.	18 knots.	18 knots.	17½ knots.	18 knots.
Coal, normal	800 tons.	..... tons.	680 tons.	650 tons.	..... tons.	..... tons.
Coal, maximum	1,200 "	1,850 "	1,100 "	..... "	..... "	1,000 "
Battery: Main	(4) 13-in.	(4) 12-in.	(4) 12-in.	(4) 9½-in.	34 guns.	(4) 10-in.
	(14) 6-in.	(12) 6-in.	(10) 5½-in.	(18) 6-in.		(8) 6-in.
	.....	.....	(8) 3.9-in.	(12) 3½-in.		(8) 4.7-in.
Battery: Secondary	(17) 6 pdrs.	(16) 12pdrs.	(16) 1.8-in.	(12) 6 pdrs.		(2) 2.9-in.
	(6) 1 "	(12) 3 "	(10) 1.4-in.	.....		(12) 1.4-in.
	(5) machn.	(2) machn.	(8) machine.	(8) machn.		(2) machn.
Torpedo tubes	4	5	4	....	....	5
Armor: Belt	16½ ins.	8 ins.	15¾ ins.	11¾ ins.	9 ins.	9¾ ins.
Casemate	5½ "	6 "	3 "	5.9 "	....	4 "
Turrets	17-15 "	10 "	15¾ "	9.8 "	....	9¾ "
Barbettes	15 "	10 "	.... "	9.8 "	....	9¾ "
Protective deck	3 "	3 "	3½ "	2.56 "	....	3 "
Splinter deck	½-in.	.....	.... "	¾ "	....	....

turret is on the main deck, with the axis of the guns 19 ft. above the same water line. Each pair of guns sweeps an arc of 135° from the midship line. Three sighting hoods are provided for each turret; one in the middle for the turret-turner, who simply keeps the guns pointed at the target, and two side hoods for the gun-pointers. The eight 6-in. guns in broadside have a total arc of train of 90°, and are each protected by 3-in. shields on the carriage and the 5½-in. armor of the sides. The auxiliary battery consists of 17 6-pdr. and 6 1-pdr. guns, mounted wherever they obtain good command and are yet clear of the blast from the heavy guns. Four broadside torpedo tubes, in the 5½-in. armor, complete the armament of these ships.

Mr. Hichborn gives the following table, showing the weight of fire of one discharge, neglecting the auxiliary battery, from all the guns available for the bearings given and for several classes of our war ships:

Class.	Ahead or astern, lbs.	Bow to quarter, lbs.
"Alabama"	2,400	5,100
"Kentucky"	2,700	5,750
"Iowa"	2,766	4,490
"Indiana"	3,400	5,600

This weight of discharge is obtained from the following primary and secondary batteries, the auxiliary battery being added for comparison:

Class.	Batteries. Primary.	Secondary.	Aux'lary.
"Alabama"	(4) 13-in. B.L.R.	(14) 6-in. R.F.	(17) 6 pdrs.
			(6) 1 "
"Kentucky"	(4) 13-in. " "	(14) 5-in. "	(20) 6 "
			(6) 1 "
"Iowa"	(4) 12-in. " "	(6) 4-in. "	(20) 6 "
			(6) 1 "
"Indiana"	(4) 13-in. " "	(4) 6-in. "	(20) 6 "
	(4) 8-in. " "		(6) 1 "

The general dimensions of the battleships of the "Alabama" class are given as follows:

Length on load water line	368 ft. 0 ins.
Length over all	373 " 9 "
Breadth molded	72 " 0 "
Breadth extreme	72 " 2½"
Freeboard forward	20 " 0 "
Freeboard aft	13 " 3 "
Freeboard amidships	19 " 10 "
Mean draft (800 tons coal, ⅝ stores, ammunition)	23.6 ft.
Corresponding displacement	11,520 tons.
Speed, per hour	16 knots.
Steam power	10,000 I. HP.
Mean draft (1,200 tons coal, all stores, etc., on board)	24 ft. 7 ins.
Corresponding displacement	12,140 tons.

General Schedule of Weights.

	Tons.
Hull and fittings, including wood-backing, etc.	4,918
Armor and bolts	2,719
Protective deck armor	593
Armament and two-thirds ammunition	864
Equipment and two-thirds stores, water, etc.	498
Machinery, with water	1,128
Normal coal	800
Total	11,520

The main propelling engines will be of the vertical, inverted cylinder, direct-acting, triple expansion type, and they will be placed in two watertight compartments, separated by a middle line bulkhead. The propelling air-pump and circulating pump engines will have a collective power of 10,000 I HP., at 120 revolutions per minute. The cylinders are 33½, 51 and 78 in. in diameter and 48 in. stroke; there are 7,000 sq. ft. of cooling surface in main condensers and 800 sq. ft. in auxiliary condenser. There will be 8 single-ended steel boilers of the horizontal-return fire-tube type, placed in four water-tight compartments. These boilers have the following general dimensions:

Length	9 ft. 11¼ ins.
Diameter	15 " 6½ "
Working pressure, per sq. in.	180 lbs.
Total heating surface for all boilers	21,000 sq. ft.
Total grate surface	685 " "
Number of furnace flues	4
Diameter of flues	39 ins.

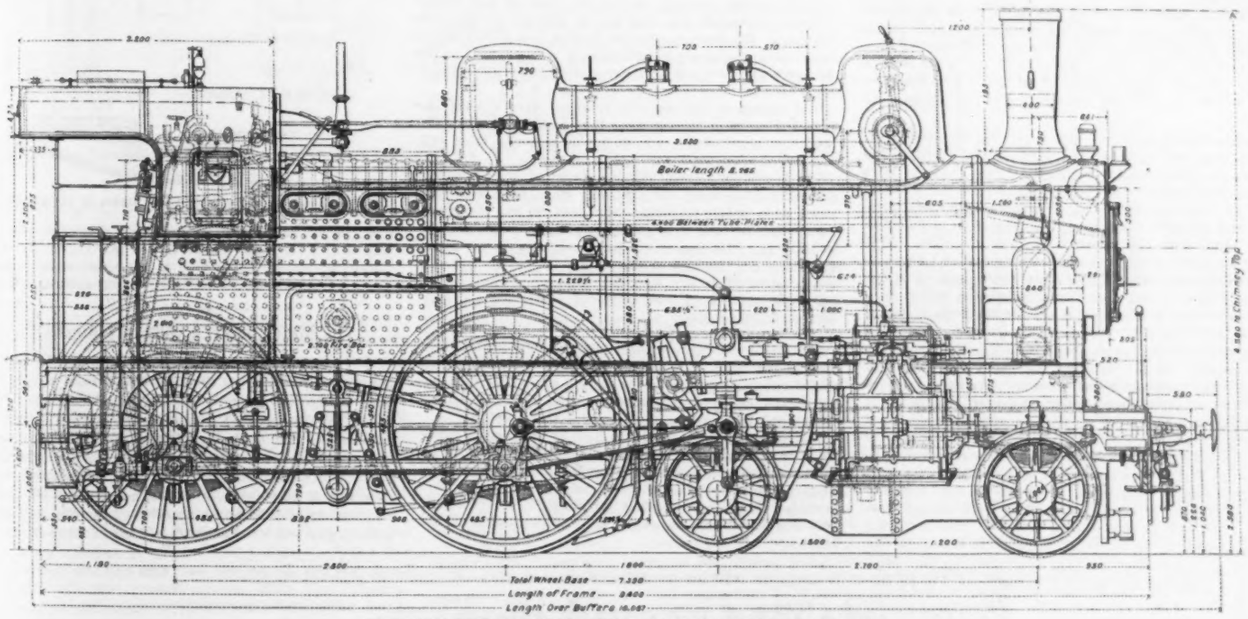
An interesting table herewith compares the "Alabama" type with the recently built battleships of foreign nations.

TWO-CYLINDER COMPOUND LOCOMOTIVE; AUSTRIAN STATE RAILWAYS.

The compound locomotive continues to grow in favor on the railways of continental Europe, and we illustrate herewith one of a large number of two-cylinder compound express engines, designed by Mr. Golsdorf, Superintendent of Motive Power of the Austrian State Railways, and built by the Wiener Locomotiven Fabriks-Actien Gesellschaft, of Florisdorf, Austria. The details of the compounding arrangement are on the Golsdorf system, which has recently been applied to a freight engine of the Pennsylvania R. R.

The engine shown is of the eight-wheel type, with a long truck wheel-base, and is of considerable weight and power, designed for heavy express service and for hauling the Oriental Express (from Paris to Constantinople) between Vienna and Linz. The trains average from 15 to 18 cars, or about 240 tons behind the tender. The general style of the engine is shown in the accompanying cut, reproduced from the London "Engineer." The boiler is of large capacity, and has two domes of 102 cu. ft. capacity connected by a horizontal pipe 11¾ ins. diameter, on which are mounted the safety valves. The throttle is in the forward dome. No special starting valve is used, but steam inlets are bored in the faces of the low-pressure steam chests and controlled by a special form of slide valve. The general dimensions of the engine are as follows:

Running Gear:	
Driving wheels (4), diam.	6 ft. 11½ ins.
Truck wheels (4), diam.	3 " 4¾ "
Tender wheels (6), diam.	3 " 4¾ "
Journals, driving axles	7⅞ × 10½ "
Journals, truck axles	7⅛ × 9⅝ "
Wheel Base:	
Driving	9 ft. 2 "
Truck	8 " 10 "
Total engine	23 " 10⅝ "
Total tender	10 " 5⅜ "
Center of truck pin to c. of leading driver	10 " 0 "
Total length of engine	33 " 0 "
Weight in Working Order:	
On driving wheels	63,392 lbs.
On truck wheels	58,912 "
Engine, total	122,304 "
Tender, total	83,776 "
Engine and tender, loaded	206,080 "
Engine, empty	109,088 "
Tender, empty	33,600 "
Cylinders:	
Size of h. p.	19⅝ × 26⅜ ins.
Size of l. p.	29 × 26⅜ "
Distance center to center	6 ft. 3⅜ "
Piston rod, diam.	3¼ "
Connecting rod, length between centers	6 ft. 5 "
Boiler:	
Diameter of barrel inside (largest ring)	4 ft. 9 ins.
Thickness of barrel plates	9-16-in.
Height from rail to center line	8 ft. 5½ ins.
Length of smokebox	3 " 11⅝ "
Working steam pressure	190 lbs.
Domes (2), height	2 ft. 10½ ins.
Firebox:	
Length inside	8 ft. 3½ ins.
Width inside	3 " 8½ "
Depth at front	5 " 0⅝ "
Depth at back	3 " 9 "
Thickness, side and back plates (copper), ½ and ⅝-in.	
Thickness of tube sheet (copper)	½ and 1 in.
Grate area	31.2 sq ft.
Tubes: Material, steel; No.	205
Diameter outside	2 ins.
Length between tube plates	14 ft. 5 "
Heating Surface:	
Tubes	1,554.8 sq. ft.
Firebox	118.3 "
Total	1,673.1 "
Miscellaneous:	
Smokestack, diam. bottom, 1 ft. 3⅝ ins; top, 1 ft. 6⅝ ins.	
Smokestack, height	4 ft. 2⅛ "
Smokestack, height from rail to top	15 " 0 "
Capacity of tank	4,422 gallons
Capacity of coal space	11,650 lbs.



COMPOUND EXPRESS LOCOMOTIVE; AUSTRIAN STATE RAILWAYS.
The Wiener Locomotiven Fabriks-Actien Gesellschaft, Builders

FRICTION HORSE-POWER IN FACTORIES.*

By C. H. Benjamin, M. Am. Soc. M. E.†

During the winter of 1895-96 a series of experiments were made under the direction of the writer to determine the ratio of the power required to drive shafting and belts in various factories in this city to the total power consumed. In the course of these investigations visits were made to 16 different establishments, comprising rolling

*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

†Professor of Applied Science in the Case School, Cleveland, O.

and stamping mills, bridge works, general machine works, and screw factories.

Indicator cards were taken from the engine during the day, at intervals of about one hour, while the factory was in full operation. During the noon hour or after working hours at night, cards were taken from the same engine when it was driving line and counter shafts only, no machines being in operation. Averages of these two sets of cards were assumed to show respectively the total horse-power and the friction horse-power of that establishment.

During the day the observers measured the lengths, diameters, and speeds of rotation of the line shafts, estimated the number and lengths of bearings, and noted the method of oiling. They also counted the belts running from line shafts and estimated their widths and the average diameter of pulleys. The number of counter shafts was noted, and the number and character of machines in operation. As far as possible an estimate was made of the actual number of men at work with machines during the day. These are the data which seemed to the writer most likely to be useful in determining the power consumed under various conditions, and while a great degree of accuracy in all the estimates was not practicable, the average results will be reasonably close to the truth.

The tabular form is best adapted to comparisons of this nature, and the accompanying table is largely self-explanatory.

The first main column of the table gives simply the data on which were based the calculations with regard to each factory. In all the tables the establishments are arranged according to the character of the work done in each. The next four columns show how the horse-power was divided between the machinery and the shafting and belts.

The percentage of power lost in overcoming friction depends more upon the arrangement of the shafting and machinery than upon the particular character of the work done. For instance, in the case of Works No. 4, there are two one-story buildings, covering considerable territory and containing machinery distributed at wide intervals. The power is transmitted from one shop to the other by a long shaft, and there are numerous transverse shafts driven by bevel gears. This would seem to be one of those cases where electrical transmission would be a good investment. A somewhat similar condition of things exists in Works No. 3.

The record of the shafting at Works No. 13 is remarkable, especially when it is noted that the works were running at only one-quarter their capacity. As the machinery is of the automatic type, very compactly arranged, the conditions are about the same as in several other shops visited; but an inspection of the shafting shows that great care has been exercised in its construction and operation. It is in perfect alinement, runs in cast iron boxes, without babbitt metal, and supported by unusually rigid hangers, while it is oiled by hand instead of by wick-oilers. That these conditions do not always obtain is shown by the remark made to the writer by the superintendent of one of the establishments visited, who said that he wished the test could be repeated, as after the first visit he had examined his line shafting, and found that one length was about 3 ins. out of line.

It will be seen that the figures for horse-power per 100 ft. and per 100 lbs. of shafting show a wide variation in different factories, since the work of friction is dependent on speed as much as on pressure.

By "HP. per 100 sq. ft. of shafting per min." is meant the friction horse-power was divided by the number of hundreds of square feet of shafting surface passing a given line in a minute, in much the same manner as the horse power of belting is often calculated. With one or two exceptions the figures in this column are nearly the same throughout, the general average for heavy and light machinery being about .046 HP. per 100 sq. ft.

The horse-power per bearing is nearly as great for light machinery as for heavy, probably on account of the greater speed of the former. The friction horse-power per counter shaft and per belt runs quite uniformly in the two classes of heavy and light machinery, being about three times as much in the former case as in the latter. It seems to the writer that either of these would offer a convenient and reasonably accurate method of estimating the horse-power required to run shafting and belts in ordinary situations.

The results given for the friction horse-power per 100 sq. ft. of belting per minute are more or less approximate, since the average size of the pulleys was rather roughly estimated; but they are as uniform as could be expected. The heavier duty per square foot of belt in the four heavy machinery establishments is partly due to the fact that the belts were thicker and required more power in bending.

The figures in the last two columns were worked out from the useful horse-power or that required to drive the machines alone, more as a matter of curiosity than with any expectation that they would be useful.

The figures for "Useful HP. per machine" are not nearly as uniform as those for shafting, since machines vary much more widely in construction than do line and counter shafts. In fact, it is not possible to give any average or state any rule that would be of value in special cases. The same may be said of the results in the last column, which show that any rule for estimating horse-power from the number of men employed would have a very narrow application.

Conclusions.

One would naturally inquire, after looking at the averages in the table, if it is necessary that from 55 to 65% of the power generated by the engine should be absorbed before the machines are reached. The isolated case of Works No. 13 would seem to answer this question.

One explanation of the large loss by friction in many shops is the fact that economizing in either quantity or quality of oil has at once a favorable effect on the bills, while the corresponding increase in coal and water consumption may be unnoticed or attributed to other causes. This is a case of saving at the spigot and wasting at the bung.

Where the loss is due to a necessarily extended and complicated system of shafting, it would be wise to determine if electrical transmission of the power would not be cheaper in the end.

No doubt it is true that to-day the question of time is more important than that of power, and that, in the endeavor to get the most product per machine and per man, the minor subject of coal and water consumption has been overlooked. This is, however, the age of small economies—economies that would have been laughed at a generation ago, and no manufacturer can afford to neglect the losses shown in these experiments.

It seems to the writer that in ordinary machinery establishments an observance of the following rules might effect a saving that would be noticeable in the annual balance.

1. Use pulleys of large diameter on counters and narrow fast-running belts.
2. Use nothing but the best oil and plenty of it, catching all drip, and either purifying it or using it for some other purpose.
3. Have all the shafting and counters oiled regularly, and do not depend too much on automatic oiling.

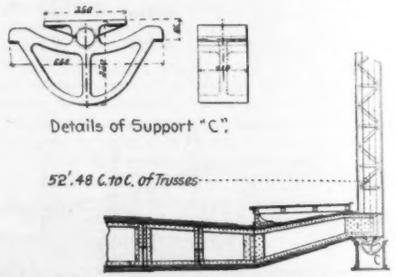


Fig. 2.—Detail of Support for Floor Beam at Vertical Posts.

4. Inspect line shafts from time to time, and see that they are in line and can be turned easily.

Many line-shaft boxes bind at the sides when screwed down, sometimes increasing the turning moment 100%.

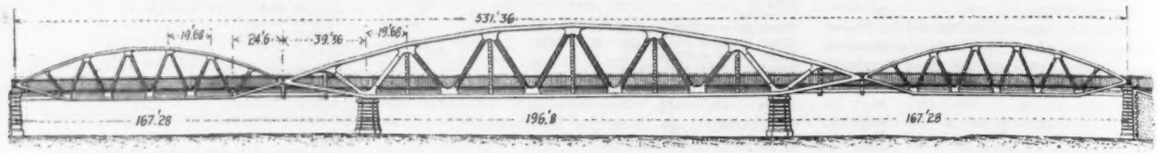


FIG. 1.—GENERAL ELEVATION OF HIGHWAY BRIDGE OVER ORLEANS RY.; PARIS, FRANCE.

A NOVEL FRENCH HIGHWAY BRIDGE.

We reproduce herewith from "Le Genie Civil," the general elevation and several details of a highway bridge of French design which is somewhat novel in one or two features. This structure is located in the city of Paris, and carries an important street over the tracks of the Orleans Ry. The conditions required that the dimensions and number of supports, or piers, coming in the railway yards should be as small as possible, and also that the street level should be raised no more than

TABLE SHOWING RESULTS OF TESTS OF THE LOSS OF POWER BY FRICTION IN 16 MANUFACTURING ESTABLISHMENTS OF CLEVELAND, O.

No.	Nature of work.	Total length of line shaft, ft.	Diam. of line shafts, ins.		Revolutions per minute.	No. bearings.	No. of belts.	Ave. width of belts, ins.	No. counters.	No. machines.	No. of men.	Total I. HP.	HP. to drive machines.	HP. to drive engines and shafting.	P. c. HP. to drive shafting.	Running at what capacity.	Friction horse-power. Per 100 ft. of shafting.	Per 100 lbs. of shafting.	Per 100 sq. ft. shafting per min.	Per bearing.	Per counter.	Per belt.	Per 100 sq. ft. belting per min.	Useful horse-power. Per machine.	Per man.
1.	Wire drawing and polishing..	1,130	2½	2¾	170	115	89	4	69	...	...	400	243	157	39.2	One-half.	14	.580	.10	1.37	2.28	1.76	.50	....	....
			4	6																					
2.	Steel stamping and polishing..	580	3	3½	200	68	28	6	27	18	78	74	17	57	77	One-third.	9.84	.352	.059	.84	2.11	2.40	.33	....	....
	Average	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11.92	.466	.08	1.10	2.19	2.08	.415	....	....
3.	Boiler and machine work.....	530	2½	3	150	46	53	5½	47	43	152	38.6	13.3	25.3	65.6	Two-thirds.	4.77	.205	.04	.550	.538	.477	.10	.310	.877
4.	Bridge machinery	1,460	2½	3	110	142	92	4½	79	69	80	59.2	11.3	47.9	80.7	Nearly full.	3.28	.137	.04	.377	.606	.521	.20	.164	.142
			4																						
5.	Heavy machine work	1,120	3		190	110	141	4	96	68	300	112	48	64	57	Full.	5.70	.233	.038	.581	.665	.453	.10	.707	.160
6.	Heavy machine work	1,065	2	3	180 150	114	192	4	152	123	225	168	77	91	54.2	Full.	8.55	.306	.06	.799	.600	.475	.15	.627	.342
			4		150																				
	Ave. heavy machine work..	....	...	...	...	...	...	...	...	...	...	...	...	...	62.3	....	5.57	.22	.044	.567	.602	.481	.14	.452	.380
7.	Light machine work.....	748	1½	1¾	135 135	101	217	3	133	250	200	40.4	19.7	20.7	51.2	Full.	2.75	.276	.034	.204	.155	.095	.04	.790	.099
			2	3	135 150																				
8.	Manufacture of small tools ..	500	2	3	114	58	335	3	314	313	226	74.3	34.3	40	53.8	Full.	8	.400	.09	.689	.127	.119	.06	.109	.152
9.	Manufacture of small tools...	900	2½	1¾	175 136	102	217	3	202	258	100	47.2	22.7	24.5	51.8	Full.	2.49	.233	.03	.240	.121	.113	.04	.881	.227
10.	Sewing machines and bicycles.	2,490	2	6	150	274	521	3	403	454	400	190	82	108	56.9	Full.	4.36	.430	.05	.397	.269	.208	.09	.180	.204
11.	Sewing machines	1,472	2	3	160 160	184	484	3	435	179	350	107	32.5	74.5	69.7	Full.	5.08	.134	.034	.406	.172	.154	.05	.181	.093
			4		125																				
12.	Screw machines and screws ..	1,800	2	2¼	180	180	486	3	392	428	320	241	127	114	47.3	Full.	6.33	.381	.05	.633	.291	.235	.09	.296	.396
			2½	3																					
	Ave. light machine work...	...	...	...	...	...	...	...	...	...	...	...	...	...	55.1	....	4.83	.300	.048	.428	.189	.154	.062	.406	.195
13.	Steel wood-screws	674	1½	2	175 160	96	131	4	80	392	140	117	100	17	14.5	One-fourth.	2.53	.109	.02	.178	.191	.130	.04	.256	.717
			3		175																				
14.	Manufacture of steel nails....	988	2½		200	74	187	3	175	184	58	91.6	45.9	45.7	49.9	Full.	4.62	.278	.035	.615	.260	.244	.07	.251	.702
15.	Planing mill	165	3		267	19	45	6	40	53	8	39.2	10.6	28.6	73	Full.	17.34	.729	.08	1.52	.715	.636	.08	.200	1.320
16.	Light machine work	275	2		175	37	48	4	27	30	..	8.28	4.26	4.02	48.6	One-half.	1.46	.138	.015	.109	.749	.084	.02	.142	....

was absolutely necessary to give head-room to the trains passing under the bridge.

Fig. 1 is a diagram elevation of the bridge as constructed. As will be noticed, the trusses of the center span are continuous over the piers and carry the inner ends of the side spans. The loads coming on the center span outside of the supports or piers produce, of course, stresses in the members of that span contrary in character to those produced by the loading between the piers. In the fewest words, the bridge is practically a continuous girder bridge, and the principle of the continuous girder, as far as the stresses are concerned, is applicable to the center trusses. The design goes further, however, and attempts to secure, besides the reduction of stresses peculiar to the continuous girder, also freedom from the danger of settling piers, by making the connections of the side and center girders flexible pin connections. The general character and purpose of the design is plainly indicated by these statements and need no further explanation except, perhaps,

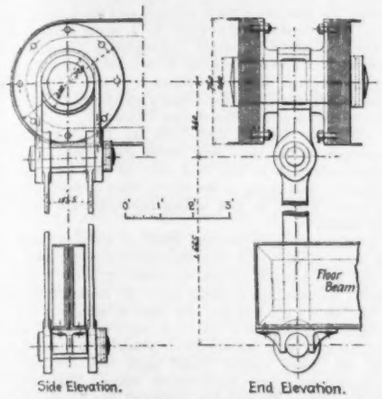


Fig. 3.—Floor Beam Hanger at Junction of Side and Center Spans.

to state that the lack of rigidity which would naturally be expected on account of the flexible joint has not been shown in the completed bridge, probably on account of the floor being a solid iron plate floor and also being placed well below the joint.

The top chord of all the trusses is polygonal, and the bottom chord is straight, except at the end panels, where it bends up to meet the top chord. Both bottom and top chords are box girders, made up with plates and angles, and all the web members are latticed channel shapes, made up of plates and angles. The trusses are spaced 52.48 ft. apart, c. to c., and provide for a 32.8-ft. roadway and two 8-ft. sidewalks. Floor beams are placed at each panel point and also at the foot of the verticals in the center span. The manner of supporting the floor beams at these vertical posts is shown by Fig. 2, and Fig. 3 shows the hangers carrying the floor beams at the junctions of the side and center spans. This last illustration also shows quite clearly the character of the pin connection at this point.

This bridge was designed and constructed by the Department of Public Works of the city of Paris, M. de Tavernier, Chief Engineer.

PROGRESS IN THE MANUFACTURE OF IRON AND STEEL IN AMERICA.*

Prior to 1838 the manufacture of pig iron was in a primitive condition, that metal being practically all made in charcoal furnaces, producing from 15 to 30 tons per week, and was converted into wrought iron in the old-fashioned charcoal fires, and was shaped into blooms for the rolling mill, and into bars for the smith, by a helve hammer. The furnaces, forges and mills were all driven by water power, and were kept in order by what was sometimes called a forge carpenter, or millwright. At this time the mills were all geared, the shafts being square, hexagon, or octagon, according to the fancy of the millwright; the wheels were secured on the square shafts by wooden blocks, and in them were driven thin iron wedges; the segments of the wheels were secured to the center in the same manner; the rolling houses were all set on wood. All this crude machinery the millwright was called upon to keep in good running order; consequently he became an important man.

In 1840 the use of anthracite coal and coke in blast furnaces was commenced. This required a much higher pressure of blast. Previous to this time the blowing cylinders had been made out of wood, the pressure of blast being very low, not exceeding 1½ lbs.; hence a great improvement in blowing machinery became necessary.

In 1842 puddling began to come into more general use, and puddling trains had to be built, and better merchant or bar trains were now required; they were all geared and gave much trouble. The machinist now had to be called in to help keep things in shape, and he soon took the millwright's place, and laid the foundation for the mechanical and metallurgical engineer.

In 1845 the rail mills were being built, and stronger and better workmanship was required. These mills were all geared, but the shafts were generally turned up, and wheels all bored out, and fitted up in a much better manner, which required more skill and better workmen. Puddling now became an important branch of the iron business, and the Old Harry was generally to pay to get the balls in proper shape; to do this mills were using the old Welsh hammer. Numbers of squeezers were tried and failed; finally the Burden squeezer was invented, and adopted by the mills generally, and to this day is the best machine that has ever been devised for the purpose.

In or about the year 1848 "boiling" came into use, which was a great improvement over ordinary "puddling," and gave a new impetus to the trade. From 1848 to 1856 there was no great change or marked improvements made in the business. In 1857 the three-high rail mill was successfully introduced, and in a very short time practically revolutionized the manner of rolling rails. From this time on all the new mills that were built were driven direct, without gearing, and much stronger and better in every way. It was during this time that the great changes and improvements were being made in rolling-mill and blast-furnace machinery, and also in machine-shop tools of all kinds, which enabled much better work to be turned out than had been previously possible; and this was an advance for the mechanical engineer, and prepared him for the great work that he was soon to be called on to accomplish.

In 1864 the Bessemer process was introduced, and it soon became evident that it would in a short time revolutionize the iron business. Its introduction and perfection will ever remain one of the most interesting and important epochs in the whole history of the iron business.

In order to show what the Bessemer process can do in coal and labor, as compared with puddling, the former can produce in 10 minutes ten tons of steel ingots, with a consumption of 1 ton of coal. It will require a puddling furnace ten days, with practically three men, to produce a like amount of puddled iron, and will require about 20 tons of coal. The puddling is a hard, laborious and exhausting occupation. With the Bessemer it is care and attention only, but that it must have.

We left the blast furnaces in 1840, making 15 to 20 tons per week, and produced in that year 286,903 gross tons. In 1895 we have furnaces producing between 2,000 and 3,000 tons per week, and others building that are expected to make much more. The total output in 1895 was 9,446,308 gross tons, which exceeds the quantity made by any other nation.

It was the marvellous increase in the production of iron and steel which took place after the year 1865 that gave such a remarkable impetus to the engineering trades. The demand for Bessemer pig iron caused new blast furnaces to be built of much larger size than formerly. The blowing engines were required to be of much greater capacity and more powerful. The material used in the construction of these furnaces stimulated other branches of business, in many instances beyond their capacity. When the Bessemer process came into use blooming mills had to be built, new rail mills, billet mills, and plate mills; in fact the introduction of Bessemer rendered the old iron rolling machinery practically useless; consequently new, heavier, and more powerful mills had to be erected.

The rail mills, with one exception, are three-high, and fitted up with tables arranged for automatically handling the work, and they are equipped with every facility that will quicken and cheapen the handling of the material. In 1866 the Siemens open-hearth furnace for making steel was introduced, but it was some time before it came into general use; the Bessemer for quite a while held it in check. To-day it occupies an important position, and, in connection with the Thomas basic process, one of the great metallurgical inventions of the age, is sure to become a strong competitor of the Bessemer process. When I allude to the Siemens open-hearth furnace I do not mean that their form of hearth and ports should be strictly adhered to, as there are other styles of furnaces which have their advocates; among them are the partial revolving hearth, which so far has shown good results, and it certainly has advantages over the fixed hearth. What I refer to is the Siemens regenerative principle, which is truly scientific and yet perfectly simple in its construction, and so far is the only method by which the metallurgist has been able to secure the heat necessary for making steel on the open-hearth plan; and all steel-melting furnaces, of whatever form the hearth has been constructed, use the Siemens regenerative principle. Much as I admire the Bessemer process and well know what can be accomplished with it, yet, if the users of steel insist on lower phosphorus, it will have to be made in the open hearth, and by the Thomas basic process, as the ores that will make steel of high grade by either of the acid processes are, so far as known, quite limited; and the Thomas basic Bessemer requires high phosphorus, as the pig iron should have at least 2%, and this is more difficult to obtain in quantity than the low is for the acid processes. Steel can be made in the open hearth, on acid lining, quite low in phosphorus, but at a greater cost, as you must start with first-class material, while the basic might be called a kind of scavenger. I do not say this in a disparaging sense, but, on the contrary, a material that is perfectly useless (so far) in either of the acid processes, can be utilized, and a fairly good steel can be made out of it, by the basic process, and it is this quality which makes it such an important improvement in the science of metallurgy. It is, however, like all other processes; if you want to make a good article you must have the proper material to start with. Now, while it is being rapidly introduced in many parts of the country, I think it proper to say that there are large users of steel of high quality that will only use the acid open hearth.

There are several other forms of steel-making furnaces, among which are the Pernot and Ponsard; both of them were designed for more rapid working. The former has an inclined rotating hearth, which keeps the metal in motion, and is supposed to work more rapidly than the fixed or stationery hearth. The later (Ponsard) is in its construction very similar to the Pernot, it being designed to work more rapidly than the Pernot, and introduces blast same as Bessemer, thereby combining the two processes by blowing the metal partially, and then finishing it by the Siemens process. Both systems use the Siemens regenerative principle.

Having given you a very brief account of the progress of the iron and steel industry from its infancy up to the enormous production in 1895, I shall now endeavor to show the wonderful changes that have been made in machine tools and shop practice.

I look back to my early days in the shop, now nearly 60 years ago, and call to my mind the equipments of the shop in the way of tools, and compare the facilities for making drawings of to-day with those at that time, when the complete outfit consisted of a board, a carpenter's square, a pair of compasses (as we then called them), a bevel, a lead pencil and a piece of chalk, and a jack plane to prepare the board for another drawing. After a time we adopted the plan of making models in skeleton, full size, especially when any motion was to be worked out, and also made, when it was possible, all the drawings full size; when too large to admit of this we would make important sections full size, and this practice I am not ashamed to follow at the present time, as it has many advantages.

The small shop tools for a lathe consisted of a hook tool with a sharp tit on the bottom to hold it on the rest (which was made of soft wrought iron); the tool was made out of a steel bar about ½ by ¾-in., generally put in a wooden stock some 2½ ins. in diameter, with a handle on the lower side. In addition to the tool just described, there was a finishing tool made in the shape of a spike-head, cutting edge on both sides, one to do the cutting or finishing, and the other to keep it in position on the rest; it also had a wooden handle, but of different construction from the handle of the hook tool, as it was held against the shoulder instead of under the arm; next was a chaser, and last, as usual, was the "doctor," to cure in a measure "drunken threads," which frequently occurred. The small tools consisted of a pair of outside and an inside pair of calipers, a file, and a steel straight-edge (home-made), 12 ins. long.

Now let us for a moment note the equipments of a modern machine shop for comparison. First, they have the great drawing room, and a good corps of men well skilled in their art, and are equipped with everything that is essential for producing work correctly and with rapidity, having special small tools for all purposes. The accuracy with which their round gages are fitted up is such that a machinist of 50 years ago could not possibly realize how it could be done.

The Bethlehem Iron Company has four lathes in use, all of the same pattern; one of them is used for what is called a cutting-off lathe, and frequently employs twelve tools, six on each side, made out of the best steel that can be had, size 1 in. by 6 ins., and are forced to cut all they will stand. These lathes have had work in them weighing over 190,000 lbs. They have planers that have finished castings that each weighed 165 tons, and the finishing of nickel-steel armor-plate requires tools of great power and special design.

In speaking of the manufactured products of iron and steel, I shall take up first the subject of forgings made of iron. These were originally made out of fagots (bundles of iron bars) heated in a reverberatory furnace, and-

*Presidential address of John Fritz, delivered at the annual meeting of the American Society of Mechanical Engineers (slightly condensed).

welded and shaped under a hammer which was generally too light; the force of the blow did not reach the centre, and the result was that forgings of any considerable size were unsound in the middle. This occurred to such an extent that, in my early connection with machinery, I discarded forged shafts entirely and substituted cast iron melted in an air furnace, and continued to use it, with one single exception, until we learned how to make, heat, forge, and treat steel in such a manner as to practically get it solid and free from internal strains, and was ready to recommend it as the proper material for shafts and miscellaneous forgings.

I shall now refer to the single exception which I have before alluded to, believing a brief description of the shafts, and giving the reason why I used wrought iron and steel in place of cast iron, which had served me so well for a period of nearly fifty years, will be both interesting and instructive to you all, as it was to me at that time. First, the reason for using wrought iron and steel in place of cast iron was, I wanted a three-throw crank for a three-cylinder engine, and had to use a built-up crank; at that time a solid forged crank of such dimensions as was needed could not have been made in this country. The stroke of the engine being short, reduced the distance from center of shaft to the center of crank pin to such an extent that I was compelled to reduce the diameter of the shafts to the smallest size consistent with safety in order to get sufficient metal between the holes in the crank to give the required strength. Steel at that time being more expensive than wrought iron, it was economy to use iron when it would answer the purpose. I concluded to use steel for the main shaft and the first crank pin, and for the others wrought iron. Not having at that time any overflow of confidence in either forged iron or steel shafts, and being anxious to get the best that could possibly be had, I consulted a friend who was using steel as to where was the best place to go for the steel shaft and crank pin, and took his advice and so ordered them. The iron shafts and crank pins were from what I considered at that time, the best forge plant in the country.

Having had some previous experience in a small way with both metals, and the results not being altogether lovely, I thought it prudent to see in what condition the metal in the center of these forgings was. In order to show this, a hole about 4 ins. in diameter was bored through the center of them all, seven in number, and all were unsound in the center; in the iron the imperfections ran longitudinally, and the 4-in. hole practically cleaned them out. The steel shaft, which was about 14 ins. in diameter and some 12 ft. in length, proved unsound in the 4-in. hole, and showed serious imperfections in the form of large cracks or openings running, as it were, circumferentially on the inside of the shaft; the hole was enlarged to about 6½ ins. in diameter, and some of the imperfections were still visible. The position of the shaft was such when in use that, should it give way, it would not be likely to do any serious damage, so we concluded to use it. When the hole was bored through the steel crank pin it showed so badly that we split it in two lengthwise. It was full of cracks, some of them extending almost to the outer edge. Its condition was frightful to a person who was contemplating the building of a large plant for the purpose of making steel forgings, as I was at that time.

My experience in making steel, in heating, rolling, and forging, had already convinced me that it would require great skill, and still greater care, to prevent imperfections in the interior of steel forgings, yet I was not prepared to witness anything approaching the condition which the splitting of this forging revealed. The chemical analysis, as I remember, was fairly good. There had been some blow holes in the ingot, as there is in too many of them.

To my mind the trouble was almost entirely due to two causes: first, the ingot had been put into a hot furnace and heated up too rapidly, pulling the center apart, causing internal ruptures; secondly, by being forged under a light hammer, in all probability using steam on top of piston, which gives a quick stroke, and does not give the metal time to flow, or the force of it to reach the center of the ingot, consequently elongating the outside more rapidly than the interior; and the imperfections, whatever they may be, are always the weaker parts, and the effect of the blow on the outside elongates them, as it were, by pulling them apart more rapidly than the sound outside of the ingot; consequently the imperfections were greatly augmented.

Mr. W. F. Durfee, in a paper read before the Franklin Institute on the "Conditions which Cause Wrought Iron to be Fibrous and Steel Low in Carbon to be Crystalline"—and a most admirable paper it is, and one which every maker and user of steel should read, and study, in regard to unsound ingots—says:

> It is a common opinion that one of the reasons why steel forgings are often found hollow in the interior is the failure to work them under a sufficiently heavy hammer, but no hammer, not even the hammer of Thor, can do more than aggravate the evil of internal ruptures of ingots in steel.

This is well said, and is a truth that cannot be gainsaid. It was due to imperfect or unsound ingots, lack of knowledge in heating, in forging, and also the want of proper skill to treat the forgings properly, after they were made, that caused so many failures in the early days of its manufacture, which made many people think and believe that there was some mysterious uncertainty in the metal, consequently they discarded its use altogether; and to some extent this impression is still in existence, and, to my surprise, only a short time since quite a prominent engineer said to me that he was still using wrought-iron shafts on account of the uncertainty of steel forgings. To those persons who were using steel low in carbon, for various purposes, I would urge the use of a higher grade of steel, well knowing it would answer their purpose better; but was answered by saying that it required too high a grade of skill to utilise it; they must have a material that any one could handle, consequently the steel was so low in carbon that it was no better than iron, and in many instances not as good. My own early experience having fully convinced me that nearly all the failures were due to the use of improper kind and grade of steel, being too low in carbon, and in most instances so high in phosphorous and sulphur that nothing but failure could be expected, yet it was useless to attempt to convince them that a higher-carbon steel of proper analysis would answer their purpose. They said no; we are going back to iron; we know what that is, and we can trust it. I was told that a machinist had let a locomotive crank-pin fall off his shoulder on the shop floor and it broke in two pieces, and I could readily imagine that a condition could exist that would render it liable to break from the most trifling cause. I also was told that in pinching a locomotive back and forth in the shop, in order to set the valves, that a steel crank pin was broken, and many other mysterious cases, as the laymen called them, were reported. At all events the general condition of steel forgings was such that it was not safe to use them where loss of life might result from failure.

I have already alluded to phosphorous and sulphur as most deleterious elements in steel. There are, however, still some people who contend that its presence to an extent not in excess of 0.12 will do no harm in low steel, and I have been told quite recently that a person who posed as a mechanical engineer and a steel maker, endorsed that position. He may be both, but I will take this occasion to put myself on record by saying that I have no use for it in any shape or form whatever, and by keeping it low you can increase the carbon, which is in the right direction for good steel.

Having shown you something of the character of steel in its early days, and its failures, and the disrepute into which it fell, let us suppose the mechanical engineers, who at that time were the men who had charge of the practical part of the steel business, would have said that steel was no good, and dropped it, and said we will go back to the old concrete of metal and cinder again, it is good enough, then where would we have been to-day? But they did nothing of the kind, and let me tell you the mechanical engineer of that day was not made of that kind of material, for the engineers who, in face of the prejudices of a continent, advocated the substitution of steel for iron, were men who regarded obstacles and prejudices as things which were made to be conquered. He having been on many occasions placed in much the same situation in other lines, had gone far enough to see that there was a valuable germ in it for the future, and, if properly cultivated, was sure to produce great results. What did he do? Took off his coat, called to his aid that all-important adjunct to steel makers, the chemist, and then went to work as he had done many times before when things looked equally discouraging, saying this looks to be a great thing, and we will put it through, and produced the grandest material for construction purposes that the world has ever known, and, as I said before, which will enable engineers to solve great constructive problems, that, but for the improvements in the art of steel making, could not have been accomplished.

The subject of hollow forgings being one in which the mechanical engineer is more or less interested, I will give a brief description of the process, and how the ingot is prepared. Having already told you that the metal is subjected to pressure while in a fluid condition, I will now commence with a cold ingot. It is first examined externally, and if there are no imperfections visible, it is then put into a powerful lathe, and after the proper discard is cut off it is then cut to the proper length, that being determined by the final weight of the forging it is intended for. Next it goes to the boring mill, and is bored out to a size corresponding to the diameter of hole in finished forgings. You now have the ingot (or such part as you want) in the best possible shape for examination; and this is not all, for the center of the ingot is always the most undesirable part of it, and the boring of the hole gets it out of the way entirely. We now have it in the most desirable condition possible for the heating furnace, where it next goes, and it is in the heating that it is exposed to its greatest danger, and where skill and the greatest possible care are required, and it must be charged in a cold furnace, which should be a preheating furnace, and heated up slowly until the heat reaches the center; it is then taken to the forge furnace, and heated slowly and regularly (in order to prevent internal strains), until it reaches the proper temperature for forging. The higher the carbon, the more care is required, especially in the first heating, it being the crucial test, and where the damage is generally done, and if once done, it cannot possibly be repaired. When it is finally brought up to the proper heat it is taken to the press, and a mandrel is put in, and the forging commenced, and this part of the operation requires skill, sound judgment and great care to see that it is worked at the proper heat, and in a manner that will not produce any undue internal strains, and in irregular forgings special care must be taken in shouldering down and in working up flanges or projections, in order to prevent "fins," or excrescences, from forming, that may unnoticed work into the body of the forging. One of the great advantages of hollow forgings over solid is that by boring out the center of the ingot the metal is reduced to less than one-half the thickness of the solid forging, and by using the press, the action being slow, the ends of the forging are convex, showing that the force of the press had reached the center of the metal, while the hammer strikes a quick and sharp blow, affecting the outside of the metal to a much greater extent than the inside or center, consequently the end of the forging is concaved, showing at once the superiority of the press over the hammer. There are other advantages in the use of the press for forging purposes, but time will not permit a proper description of them.

The first shafting made was in 1888. The tensile strength of the steel was about 60,000 lbs., and elongation about 28 or 30% in 2 ins. At that time but little attention was given to the elastic limit or the contraction of area, which is now considered important, especially the latter.

I shall now give you the result of some physical tests in order to show the progress that has been made. First I will give one test of iron as a starting point, it being up to the introduction of cheap steel, the metal of the world. I can only give you the one test, it being the only one available at this time, but it is more than a fair one for comparison of a wrought-iron shaft with one of steel, for no such results could have been obtained from wrought-iron shafts as formerly made. The tests were taken from a puddled bar reworked car axle. The tensile strength in the different test bars taken from this axle vary between 44,000 and 45,000 lbs., the elastic limit between 18,000 and 23,000 lbs., the elongation between 21 and 27%, the contraction of area between 40 and 48%. Compare this with some results obtained in hollow-forged, oil-hardened, and annealed nickel-steel shafting, the physical properties of which are: tensile strength, 95,000 to 100,000 lbs.; elastic limit, 60,000 to 65,000 lbs.; elongation, 20 to 25%; contraction of area, 55 to 60%. It is safe to assume that in shafts of any size a nickel-steel shaft as above would have three times the elastic strength of a wrought-iron shaft, and taking into consideration the fact of hollow forging with judicious proportioning of inside and outside diameter, it would be possible to make a nickel-steel shaft of one-quarter the weight of a wrought-iron shaft, and obtain the same elastic or working strength. The greater contraction of area shown by the nickel steel proves it a safer material against shock, as the greater the contraction the greater will be the amount of local distortion that can take place without rupture. This is clearly shown by the old but still reliable bending test, which is always in proportion to the contraction of area, and not to the elongation, as most commonly supposed.

This nickel-steel test is no fancy one gotten up for show, but was taken from the forging, and was the test the work was actually accepted on, and was taken from a prolongation of the forging of a shaft 17 ins. diameter, and the hole was 11 ins. diameter. You will notice that the shaft which this test was taken from was specially treated by oil-hardening and annealing. While I am fully aware that there are many persons, and some of them high in authority, that doubt the propriety of such treatment, yet when the work is in a proper shape to receive the treatment, and it is made with intelligence and care, my experience has fully convinced me that this special treatment produces the best possible results, and for many purposes it is indispensable. Steel can be made higher in tensile strength and elastic limit than the test referred to, but to some extent it will be at the expense of extension and contraction of area.

Under ordinary conditions the elastic limit is about 50% of the tensile strength. In order to increase this proportion special treatment of the forging is resorted to. The elongation and contraction of area are also increased by treatment, especially the latter, so that with the elastic limit and contraction we have a safe index as to the condition of the metal, and as these two properties vary much less with the length and diameter of test bar, they are more valuable in comparing results from varying sizes of test bar. As the carbon in steel increases, the varia-

tion, due to work reduction, becomes less, while that of annealing becomes greater. The variation obtained by treatment increases rapidly with increasing carbon.

Steel .45 in carbon showing:

Tensile Strength.	Elastic Limit.	Elongation.	Contraction of Area.
90,000	45,000	15	40%
By oil-tempering: 90,000	55,000	18	50%

The above are about the best figures to be used in forging ordinary work. If higher or lower strength is required, it may be obtained by varying the carbon. If increased strength and elastic limit are required, without sacrificing toughness, it may be obtained by using nickel steel.

As illustrative of the advantage of the use of higher carbon steels may be cited the piston rods of steam hammers, especially those of large size, where the strains were found too severe for the softer steels to stand them for any length of time, proving beyond question the value of considering the effect of the fatigue of metals, rather than a rupturing force of sudden application. In view of the above well-known facts it must seem strange that many progressive builders of steam engines still continue to use soft steel rods as an alleged means of safety. In this instance it seems fair to congratulate the bicycle-maker as the first to recognize the value of the development in the manufacture of steel, with all its salient advantages, with regard to combining strength with lightness.

The modulus of elasticity being constant in both high and low carbon steels, cases may arise in structural work where the higher steels, owing to the greater care necessary in working, with the consequent increase of cost, may offer no compensating advantage over the use of softer steels.

In conclusion, the modern practice of steel-making has, in the hands of the mechanical engineer, the metallurgist, and chemist, wrought wonders in producing a material which in quantity, physical qualities, and cheapness, would have been regarded as utterly impossible half a century ago when steel rails, beams, angles and plates were not thought of, and steel was regarded as a luxury of the material of the working artisan. The labor of the men of iron and steel have so cheapened their products that to-day we are enabled to use steel for the commonest purposes as well as for the most expensive articles produced by the skill of the mechanic. No article is too humble to be made of it, and no structure so grand and important as to refuse its services; it is demanded in the frying-pan as well as in the vast bridges and viaducts, as well in the housewife's needle as in the great leviathans that have made the ocean but a span of less than a week; thus we find steel asserting its value through every walk of life, and extending to every clime, linking lands in that bond which grows broader and stronger with the years, till even now we can see, if but dimly, on the horizon the promise of the linking of nations in the universal brotherhood of mankind, and bringing the longed-for era of eternal peace.

TRIAL OF STEAM JACKETS ON A LOCOMOTIVE ENGINE.*

The object of this experiment was to ascertain the advantage gained by jacketing the cylinders of a locomotive engine. The trials were undertaken, and carried out on the Lancashire & Yorkshire Ry. (England), at the suggestion of Mr. John A. F. Aspinall, Chief Mechanical Engineer.

Owing to the fact that these trials were carried out on a locomotive doing its ordinary train service, it was impossible to obtain results as complete and thorough as would have been aimed at had the experimenters been able to make the trials on a special train, the working of which could have been arranged to meet the necessities of the experiment. The trials were of short duration, and the condition of the fires at the start and the finish of each had to be determined by the necessities of the traffic requirements, and could not therefore be varied to suit the wishes of the experimenters. The consumption of steam was obtained with a close approach to absolute accuracy; but the same cannot be said respecting the fuel consumption, owing to the above circumstance with regard to the condition of the fires. The results obtained are therefore not such as will enable any definite conclusions to be drawn as to the value of the steam jacket on locomotives, but they are nevertheless interesting and valuable.

The experiment was made on a passenger locomotive, No. 1093, during its regular work of taking the 7.30 a. m. express train from Manchester to York, a distance of 76½ miles, and returning with the 3.0 p. m. express from York to Manchester. Both engine and tender are the ordinary standard pattern of this railway. The engine is of the eight-wheel type, the driving wheels being 7 ft. 1 in. diameter and the truck wheels 3 ft. 0½ in. The cylinders are inside and horizontal, with their valve chests on the top. The engine wheel-base is 21 ft. 6½ ins., and the total wheel-base of engine and tender 41 ft. 1½ ins. The weight of engine and tender when empty is 56.287 tons, and when in working order 70.925 tons, the tender carrying 1,800 gallons of water. The boiler is of steel, 4 ft. 2 ins diameter and 10 ft. 7⅜ ins. long; the fire-box shell of steel, and the fire-box of copper, 6 ft. long, 4 ft. 1 in. wide and 5 ft. 10 ins. high. There are 220 tubes, 1¾ ins. outside diameter. The heating surface in the tubes is 1,108.73 sq. ft., and in the fire-box 107.68 sq. ft.; total, 1,216.41 sq. ft. The grate area is 18.75 sq. ft., the ratio of heating surface to grate area being 65 to 1. The fire brick arch in the combustion chamber is about 2½ ft. long. The height of the chimney above the fire grate level is 10 ft. The cylinders were originally of the normal pattern, 19 × 26 ins. For this experiment they had been bored out and fitted with cast-iron liners, which reduced the internal diameter to 17½ ins., thus providing a body jacket of ⅝-in. space. The front cylinder covers were fitted with external covers, the space between the two forming a steam jacket. The back covers, however, were imperfectly jacketed by fitting over them, as close to the actual covers as possible, an annular wrought-iron ring with an inner and outer cover, the space between the latter two forming a jacket space. The external surfaces of the end jackets were much exposed, and not well covered. The proportion of the clearance surface jacketed is only about a quarter of the whole, and this is mainly due to the cover jackets; of the back ends, therefore, a large part is hardly jacketed at all, in the true sense of the word.

Four trials were made, lettered A, B, C, D, on Sept. 18 and 19, 1894; A unjacketed and B jacketed on the 18th; C jacketed and D unjacketed on the 19th. A and C were made on the runs from Manchester to York, and B and D on the return runs from York to Manchester. On each trial the weights of coal and feed-water consumed were measured, and readings of the various gages were taken, and the position of the reversing gear was noted. Indicator diagrams were obtained, and in trials C and D samples of the furnace gases were collected from the smoke-box below the exhaust pipe.

Samples of the coal were submitted to Mr. Charles J. Wilson for determining the calorific value in a calorimeter. The mean value from his tests was 14,200 thermal units per pound of dry coal, equivalent to an evaporation of 14.7 lbs. of water from and at 212° F. The coal was placed on the tender in sacks holding 200 lbs. each; and the time of emptying each sack upon the foot-plate was noted, as well as the total weights. An attempt was made to have the fire in the same condition at the end of each run as at the start; but it was difficult to carry out this arrangement, since the trials were made during ordinary runs, and could not be allowed to interfere in any way with the regular working of the traffic. The grades at the two ends of the journey are different, and different fires were therefore needed to ensure adequate steam at the beginning and end of each run. The ashes and clinkers from the smoke-box and fire-box were weighed off at the end of each run, but those in the ash pan were weighed only at the end of each double journey. As each trial lasted only about two hours, errors introduced by variation in the condition of the fire might be thought to bear rather a large proportion to the total coal consumption; but, bearing in mind the rapidity of consumption, amounting to about 50 lbs. or 60 lbs. per sq. ft. of grate per hour, this was probably not the case. The actual coal consumption per indicated horse-power per hour of steaming time in the four journeys was respectively 2.87, 3.07, 2.73 and 2.79 lbs.

The difficult operation of collecting the gases while going at express speed was carried out by Mr. Michael Longridge. They were drawn off through a ¼-in. copper pipe, and then through a rubber pipe into a gasometer containing water, whilst a branch pipe led to a collecting bottle filled with mercury. After drawing off all the air in the pipe connections, the cock on the branch was opened, so that part of the current of waste gases passing to the gasometer could be diverted and collected by displacement over mercury in the collecting bottle. During the outward journey C much trouble was experienced, owing to the heavy chimney-blast; but in the return journey D everything worked quite satisfactorily. The mean results of the three analyses made from the sample collected on each journey are the following volumetric percentages: Trial C, carbonic acid, 12.85%; oxygen, 4.15; carbonic oxide, 0.80; nitrogen, 82.20. Trial D, carbonic acid, 15.10; oxygen, 1.97; carbonic oxide, 0.85; nitrogen, 82.08%. The feed-water was measured by means of a Siemens water meter on the pipe between the tender and the injector. It was originally intended to have a means of making direct measurement of the feed-water. The meter was read at the time of starting from each station, and thus a fair approximation to the rate of consumption was obtained, as well as the total quantity. The overflow from the injector was caught and allowed for. After the trials were over, the meter was sent to University College, London, and tested there by Prof. Beare at rates of flow similar to those in the trials. The error was somewhat variable, but the meter was found to be registering on the average 2.6% too low. In order to be able to correct for differences of level in the boiler, the quantity passing through the meter to raise the level in the gage glasses one inch, for each inch in their height with the engine standing under full steam, was determined by Mr. Donkin after the trials.

The jacket was drained into three small tanks carried upon a temporary staging on the front of the engine; one measurement was made for the two body jackets together, another for the two front covers, and a third for the two back covers. While standing at York on each day radiation tests were made, by measuring the quantity of steam condensed in each pair of jackets with the engine standing, all hot; these lasted 2½ hours on the first day and 1½ hours on the second. The following were the results obtained:

Condensation of steam in jackets, lbs. per hour.

	—While running.—		—While standing.—	
	Sept. 18, B.	Sept. 19, C.	Sept. 18.	Sept. 19.
Two body jackets...	267	241	25.0	26.7
Two front covers...	123	103	16.0	13.7
Two back covers...	65	55	12.0	15.8

The times of passing all the stations were noted, and also the times during which the steam was shut off, in order to determine the actual running time and the actual steaming time in each trial. Whenever a set of indicator diagrams was taken, a note was made of the boiler pressure, of the pressure in the jackets, of the position of the reversing gear, and also of the gradient and mileage.

Indicator diagrams were taken simultaneously from both ends of each cylinder. The springs of the indicators used were not tested for errors, since these would not affect the comparative results of the four trials. Unfortunately no counter was fixed for the trials, as had been intended. The speed in miles per hour was continuously registered by a Boyer speed recorder upon a paper wound on a drum which was driven from the rear truck axle. If this instrument recorded correctly, the circumfrence of the driving wheels being known and all slip neglected, the revolutions per minute of the driving wheels can be calculated. An attempt was made to count the revolutions at the time the diagrams were being taken; but it was found impossible to do this correctly at the high speeds. After much deliberation, it was decided to make a series of tests of the Boyer recorder, by driving it at known speeds, in order that any errors in the diagram it recorded might be ascertained. This was afterwards done by Mr. Donkin.

Comparing trials A and C, both from Manchester to York, the jacketed trial C shows a consumption of 24.49 lbs. of steam per I. HP. per hour against 26.70 lbs. for the non-jacketed run A, or a saving of 8.3% by jacketing. Comparing trials B and D, both from York to Manchester, the figures are 24.48 lbs. and 24.87 lbs. respectively, or a saving of 1.5% by jacketing. Comparing the figures for coal consumption in trials A and C, the jacketed trial C shows an economy of 0.14 per HP. per hour, or practically 5%, the increased consumption per train mile on this run being accounted for by the greater load hauled; the load was 8% greater in C than in A, the average speed being nearly the same in both runs. Comparing trials B and D, however, the jacketed trial B is distinctly less economical, the coal consumption being 0.28 lbs. greater per HP. per hour than in the non-jacketed trial, or 10% more; and the consumption is also greater per train mile. In these two trials, while the weight of train hauled was the same, the speed was nearly three miles an hour greater in the non-jacketed run D, with a correspondingly much increased horse-power.

*Abstract of the report of the Research Committee of the Institution of Mechanical Engineers on "The Value of the Steam Jacket," by Professor T. Hudson Beare and Mr. Bryan Donkin.

A WATER POWER PLANT WITH ELECTRIC TRANSmission, in which the water power is developed under a head of 1,000 ft. is in process of construction near Jackson, Cal., by the Blue Lakes Water Co., of 202 Sansome St., San Francisco.

THE NEW UNITED STATES NAVY is fully discussed in the annual report of Secretary of the Navy Herbert. Congress has authorized the present administration to build 28 vessels with an aggregate tonnage of 65,886 tons; of these, 5 are first-class battleships, and 16 torpedo boats. As to the increase of the navy he says that on June 30, 1893, we had in commission 30 vessels aggregating 62,820 tons; on June 30, 1896, we had 40 ships in commission, aggregating 122,528 tons, with 8,165 men and 1,378 apprentices. On Dec. 1, the "Brooklyn" and "Puritan" went into commission, bringing the total tonnage up to 137,850 tons. During the last four years the following guns have been manufactured: 70 4-in., 71 5-in., 6 6-in., 45 8-in., 1 10-in., 8 12-in., and 12 13-in.; and at the present date there are 196 guns in course of manufacture, ranging from 4 to 13-in. In addition to the above, 100 3-in. field and boat guns are on hand. Secretary Herbert recommends the immediate building of three battle-ships of 23 ft. draft, for use in the Gulf and at harbors in the North not admitting vessels of deeper draft, and also 12 more torpedo boats. He advocates the increase of the steam engineering staff to 250, the present limit, and proposes to save money by laying up heavy ships in ordinary, with only sufficient crew to keep them in working condition.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Published every Thursday at Tribune Building, New York. Entered at the Post Office, New York, as Second Class Matter.

D. McN. STAUFFER, CHARLES WHITING BAKER.....EDITORS.
WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, A. B. GILBERT.....ASSOCIATE EDITORS.
CHAS. W. REINHARDT.....CHIEF DRAFTSMAN.

GEO. H. FROST, F. P. BURT.....BUSINESS MANAGERS.
ALFRED E. KORNFELD, New York.....
F. A. PECKHAM, Chicago.....ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE.....Tribune Building, New York.
CHICAGO OFFICE.....1636 The Monadnock.
LONDON AGENCIES: KEGAN PAUL, TRENCH, TRUEBNER & Co. (Limited), Paternoster House, Charing Cross Road; SAMPSON LOW, MARSTON & Co., (Limited), St. Dunstan's House, Fetter Lane.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5 00; 6 months, $2.50; 2 months, $1.00; Single copies, 15 cents. To all other countries in the Postal Union, add $2.08 per annum (4 cents per number) to above prices for postage. No club rates allowed. Mailing addresses may be changed at will by sending both old and new address. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug 6) of the year 1896; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The account of a test of a locomotive with steam jackets on its cylinders, which is given on another page of this issue, is of interest because it is a record of an experiment in a field almost or quite untouched rather than because of any definite results obtained which show either the value or the absence of value in this application of the steam jacket. The trifling gain shown by one comparison is as inconclusive as the small loss shown by the other. It is to be doubted, in fact, whether any road test of a locomotive could be relied upon to give reliable results as to the economy or waste which a steam jacket might cause. American experience goes to show that accurate results in short time tests on a locomotive are only to be obtained by tests of the machine on a stationary plant, such as that which the enterprise of Purdue University has established, or that of the Chicago Northwestern Ry.

As to whether a steam jacket might be expected to effect a fuel saving on a locomotive or not, opinions will doubtless differ very widely. On the one hand the locomotive has a high ratio of expansion and a wide range of cylinder temperatures which would favor economy by the steam jacket. On the other hand the loss of heat from the exterior surfaces of the cylinders would be much greater than in stationary engines, and would continue while the locomotive was standing still. The jacket water would doubtless have to go to waste, too, instead of being returned to the boiler, as in stationary practice. Still, we do not see why there are not quite as good chances of good results in this as in many other of the new departures proposed for improving the locomotive, and we hope some American engineer or railway company will make a trial of the scheme.

The serio-comic water war in Jersey City has been resumed, but with little prospect of an early termination. A contract has been awarded by the Street and Water Commissioners, as noted in our news columns, to the East Jersey Water Co., but the rival bidder and some of the citizens are reported as sure to fight it in the courts, should it receive the approval of the various city authorities, which still have to pass upon it. The main legal objection to the award thus far made is that it is for a single pipe line, whereas the specifications call for two or more conduits. The contestants seemed to have overlooked the fact that the specifications call not only for "either two or three pipes," but also that these must be "of equal capacity." The defeated bidder proposed one 35,000,000 and one 15,000,000-gallon conduit. The successful company made two bids, one for a 50,000,000-gallon conduit and the other for two 25,000,000-gallon conduits. Neither the one single pipe line nor the two of unequal capacity comply with the plain provisions of the specifications, and the two of equal capacity are distinctly at variance with the apparent intent of the specifications.

These specifications emphasized the fact that the city wanted two distinct advantages, or what it considered as such, offered it: (1) More than one conduit, as a safeguard against accident to the supply; and (2) a choice between buying works with capacities of 35,000,000 and 50,000,000 gallons, respectively. To this end the plural, "conduits," is everywhere used throughout the specifications, and it is stated, first, that the contractor must provide storage and "conduits" with a capacity of 35,000,000 gallons; next that he must increase these, on demand, to 50,000,000 gallons, and that, speaking of the "conduits," "when so increased where metal pipes are used, there shall be either two or three pipes of equal capacity." Finally, the bidder was required to name a price at which he would sell to the city works of either of the capacities named. Obviously, the only way in which all these conditions can be met is by building two 17,500,000-gallon conduits at the start, to give 35,000,000 gallons of carrying capacity, and then adding another one of the same size, in case the city ordered the plant increased to 50,000,000 gallons. A 35,000,000-gallon pipe at the start fails to give the city the safety which it thought would result in having two conduits; and either a single 50,000,000 or a double 25,000,000-gallon line, built at the outset, deprives it of the full advantage of the lower cost of a 35,000,000-gallon supply. This advantage may or may not have been more fancied than real, but the specifications demanded it and the unsuccessful bidder was governed accordingly, put in a bid for two pipe lines instead of one, in case the works were to be increased to 50,000,000 gallons, and now finds himself the highest bidder on this basis, although the lowest for a 35,000,000-gallon plant. The successful bidder names the same figure for the smaller as for the larger plant, and thus the city gains nothing by its efforts to make it easier for it to become the owner of its water supply. On the basis of buying water by the million gallons, the successful bidder is the lowest one on all the quantities involved, but the difference would be only 80 cts. per million gallons when the full 50,000,000 gallons was required, and might well have been on the other side, and greater in quantity, had the specifications plainly said that bids were wanted on a single 50,000,000-gallon conduit.

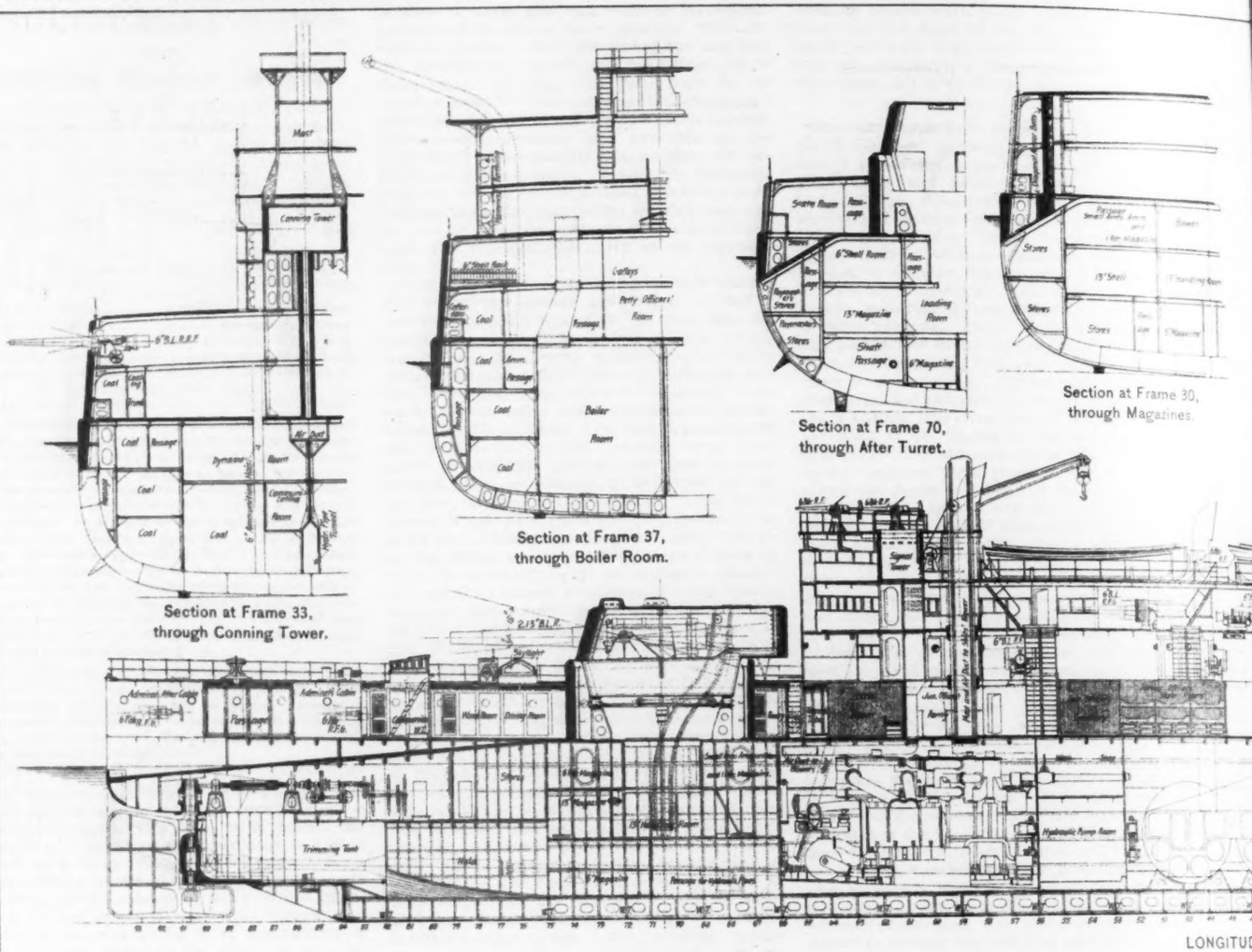
If the plain language and intent of the specifications is to be regarded, it appears to us that the Rockaway & Hudson Water Co. is fully justified in its claim that the award to its rival is illegal, being based on conditions more favorable than the specifications admit. But the only advantage the Rockaway Co. can reap from upsetting the award to its rival seems to be a possible new opportunity to bid on the contract, since its own proposals are also at variance with the specifications.

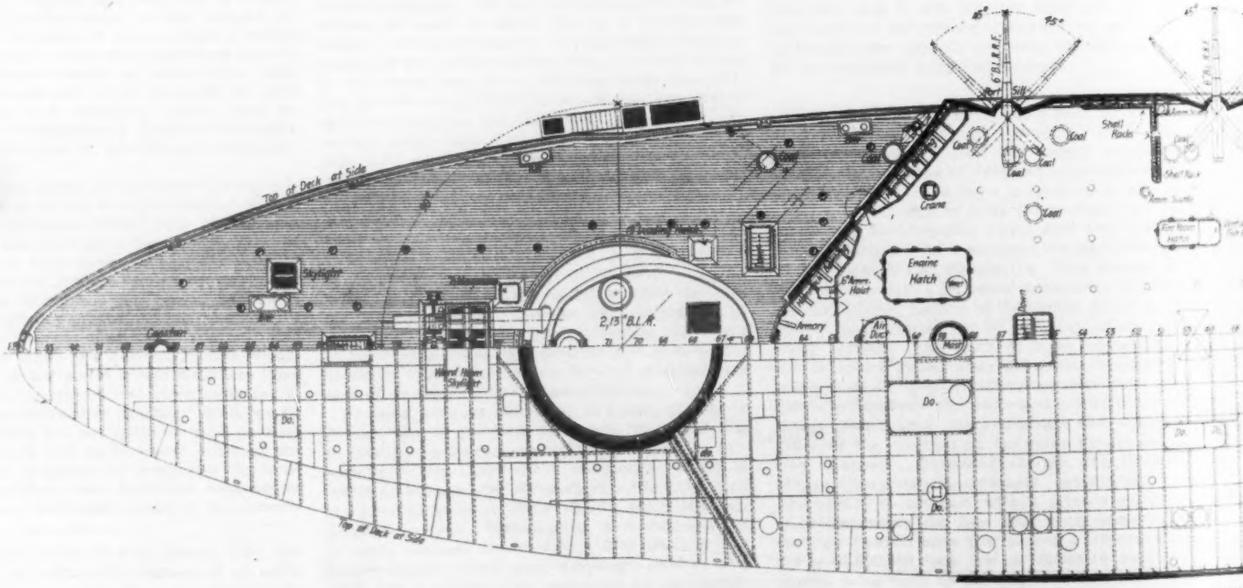
Perhaps more amusing still, to people outside of Jersey City, is the fact that while this matter is in dispute the East Jersey Water Co. will be furnishing Jersey City with a temporary supply of water at $43 per 1,000,000 gallons, or $8 more than the average price it would receive under the permanent contract. Unless some new arrangement is made between the company and Newark, the former cannot continue the temporary service after 1900, but a modification was made in the specifications before the last call for bids, giving contractors three instead of two years to build works, so if it found it advantageous to do so, the East Jersey Water Co. could take care that its permanent supply was not ready until the last extra dollar had been secured from the temporary supply contract. This all shows most excellent business management on the part of the company, but the ways of the city authorities for years past have been inexplicable, when viewed from the standpoint of those who believe in able and honest city government.

England is apparently going wild over the passage of the Light Locomotive act, which now permits a mechanically propelled vehicle to travel faster than "four miles per hour" over British highways, and does away with the old enforced necessity of sending a man with a red flag ahead of all such vehicles. About the middle of last month a parade of motor cars was organized in London to celebrate the so-called Emancipation act; and as measured by public enthusiasm, great crowds, speeches, etc., the demonstration was a veritable triumph. About thirty or forty motor cars participated in the race, for race it was, says London "Engineering," in spite of all efforts to make it a procession. These cars represented every type that had stood the test of previous trial, and a number that either worked badly, or would not work at all, "owing to the dense crowds." Practically all of the cars taking any active part in the exercises were propelled by oil engines, giving out clouds of vapor and the rank smell of benzine. They steered well as a rule; but they were very much at fault in starting off; generally going ahead with a rush, after a succession of preliminary "bucks," and break-downs in some detail were frequent. "Engineering" editorially describes the whole demonstration as a farce, and warns its readers that despite the blatant prospectus of the motor-car promoter, a vehicle of this type, of practicable form and fit to be used by the thousands as a substitute for horse-drawn carriages does not yet exist. Some years of patient study and experiment are yet needed to develop the acceptable motor-carriage; and meanwhile the innocent public had better abstain from investment in enterprises of this class, for the "boom" will surely be followed by a most decided "slump." It is satisfactory to know that the people of the United States are less sanguine of the immediate use of motor-carriages than are the English and French, and the American promoter makes so little progress at home that he goes to England to sell stock in his new and crude device. Like every other revolution in methods of transport, time and experience are required to develop the new idea and to make the road motor a practicable machine fit for every-day use; and in this country especially the improvement of the surface of city streets and country roads must precede any very extensive use of the mechanically propelled carriage.

Philadelphia might have had a pure water supply, in place of its present foul one, many years ago if half the energy wasted to further the schemes of speculative promoters for its improvement had been devoted to a sensible and honest attempt to solve the problem in a scientific and business-like way. Just now there is much agitation over a proposed contract with the Philadelphia Water Supply Co. This concern offers to enter into a 50 years' agreement to relieve the city of the burden of delivering water to its reservoirs in return for 60 per cent. of its gross water receipts. The water is to be brought from the Delaware River, after filtration, through two conduits of 175,000,000 gallons capacity each. The city is to distribute the water and collect the water rates, maintaining them through the whole 50 years of the contract at the same figures as are now charged. Curiously enough, the Council's Water Committee is seriously considering this proposition to contract with a private company, notwithstanding the fact that both branches of the City Council have just passed a bill providing for a $3,000,000 loan for a filtration plant, or plants, to be built by the city.

Aside from some highly objectionable details of the proposed contract, in themselves sufficient to condemn it, the general principle of turning over to a company any part of the water supply system of a great city is a bad one. We will not further discuss this scheme at present, but leave it to faithful and intelligent public officials, and an en-

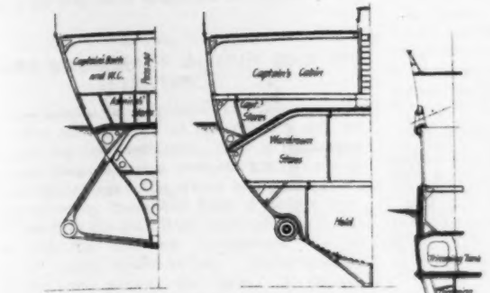




THE NEW U. S. BATTLESHIPS O

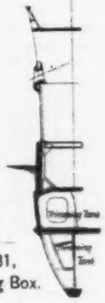
(From Drawings Accompanying a Paper by Philip

Read at the Fourth General Meeting of the Society

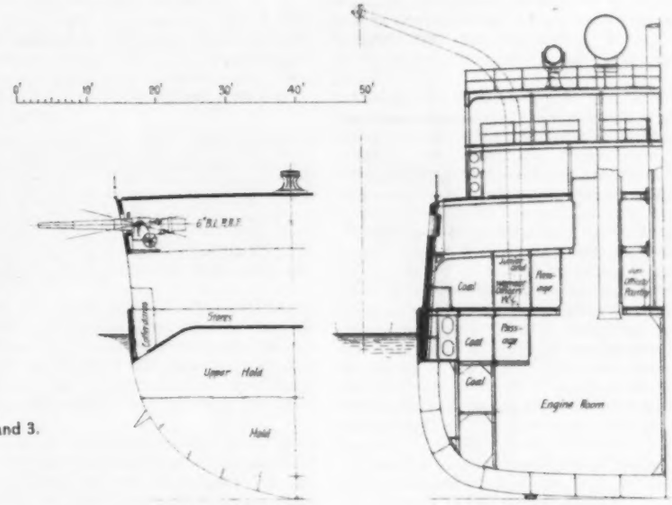


Section at Frame 89,
Showing Shaft Bracket.

Section at Frame 81,
Showing Shaft Stuffing Box.

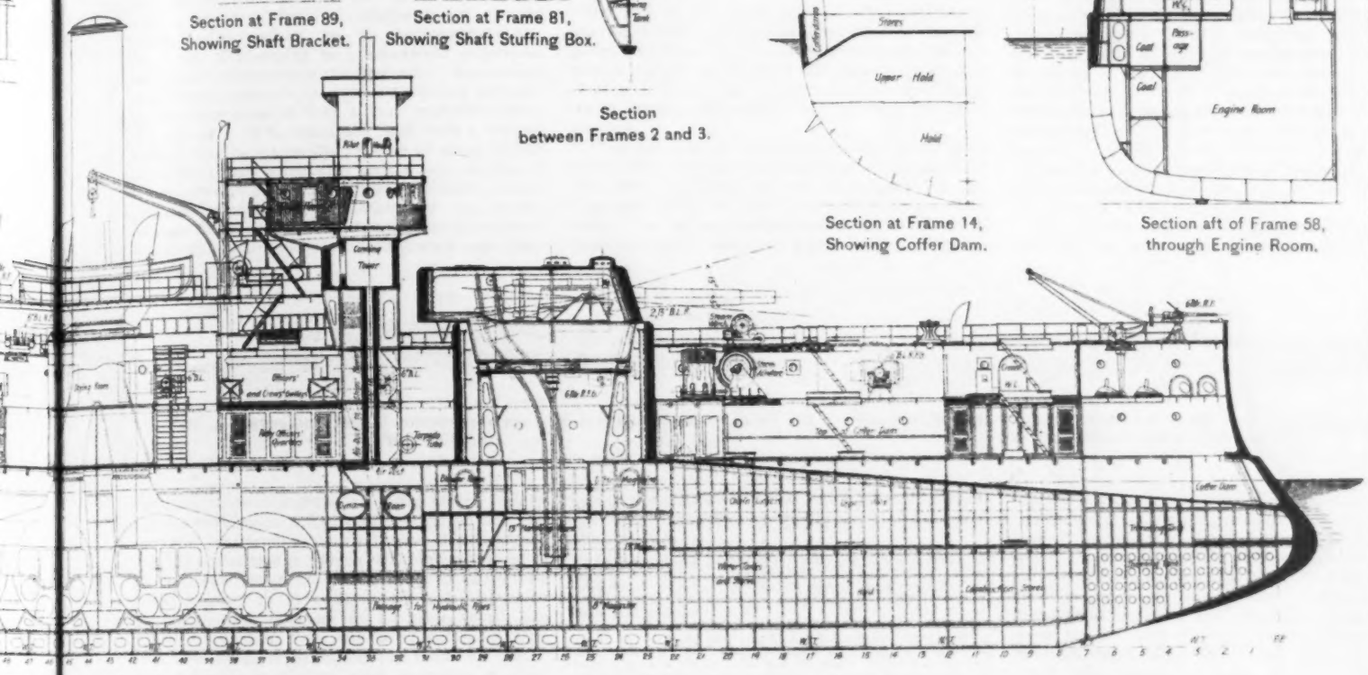


Section
between Frames 2 and 3.

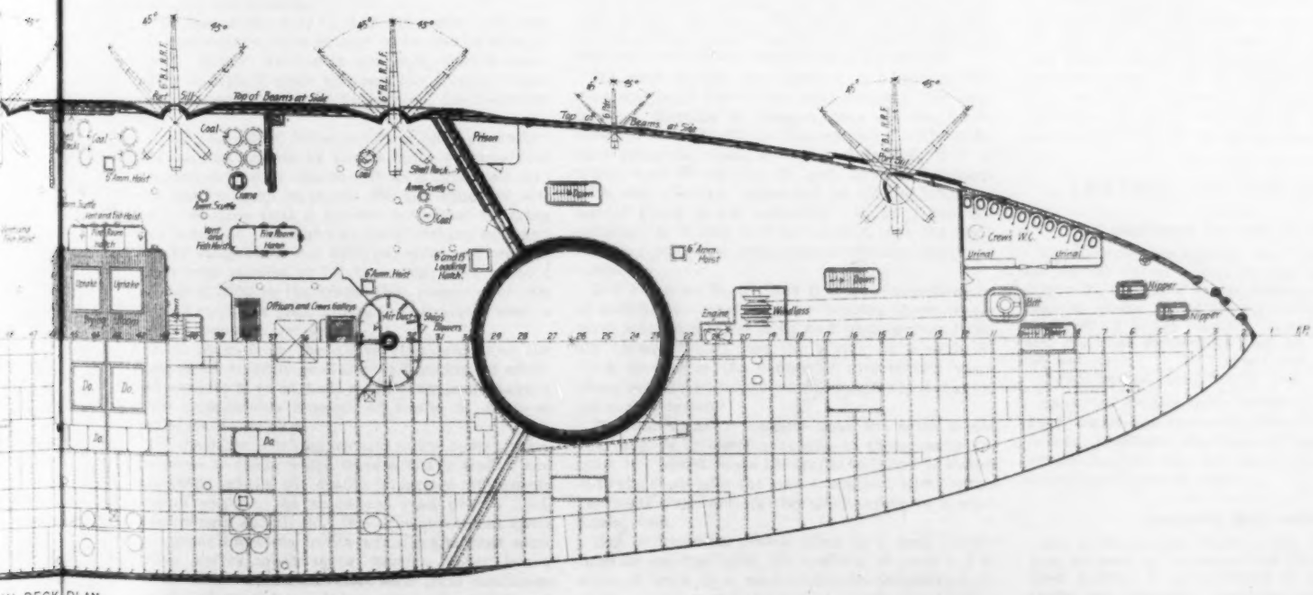


Section at Frame 14,
Showing Coffer Dam.

Section aft of Frame 58,
through Engine Room.



TUDINAL SECTION.



N DECK PLAN.

SHIPS OF THE "ALABAMA" CLASS.

r by Philip Hichborn, Chief Constructor, U. S. Navy.

the Society of Naval Architects and Marine Engineers.)

CHAS. HART & SONS, LITH., 96 VESEY ST., N. Y.

lightened press and people, who will doubtless dispose of it as they have of similar proposals in the past.

A NOTABLE DEPARTURE IN MACADAM ROAD CONSTRUCTION.

We have several times pointed out in these columns a fact which many of our readers are, we know, learning by experience, that a macadam road is far from being a durable highway. In the "good roads" agitation which has gone on for a decade or more, there has been a certain tendency to hold up the macadam highway as a panacea for all ills and an absolutely perfect system of road construction. Unfortunately this is by no means the case. A broken stone covering for a highway, if it is made thick enough to be reasonably durable, must of necessity be a somewhat expensive system of construction, in first cost. In eastern New Jersey, where trap-rock is abundant and can be generally secured with a very moderate haul, the cost of a 16 ft. macadam road with a telford bottom may be set on the average at about $5,000 per mile. Roads which cost such a sum are out of the question in purely agricultural districts, except possibly for much traveled highways. In Northampton County, Pa., the County Commissioners are about to build some samples of good road construction in several different towns of the county for the purpose of interesting the people and the township authorities in good road construction. But the committee in charge of this matter strongly recommended that the sections of improved road proposed to be built should not cost more than $1,500 per mile, as the township authorities would not accept more expensive prices of construction as good examples for them to follow. The difficulty in making good examples of macadam road at this figure will be apparent, we presume, to our readers.

The fact of the case is (and the people who pay for road construction appear to be aware of it, if "Good Roads" advocates are not), that a macadam or telford road will not pay except where there is traffic sufficient to warrant its construction.

It may be asked, What is this amount of traffic? We can best explain by an example. Suppose that a certain highway can be left as a dirt road and will cost to keep in repair $50 per mile per annum. Suppose that a narrow macadam covering can be laid on this highway for $2,000 per mile and can be maintained for $150 per mile per annum. Then with interest at 5% there will have to be a saving of $200 to the traffic that passes over this mile of road in a year, unless the macadam road is to be a losing investment.

It is plain from the above that wherever the natural soil is fairly good for roadmaking, or wherever gravel is to be had, a highway must have a very considerable amount of traffic in order to make macadam pay.

On the other hand, as we said at the outset, when we come to roads which have a heavy traffic, and especially where the traffic is largely of heavily loaded wagons, the macadam road proves itself surprisingly shortlived. We are aware that there is a great difference in macadam roads, that some stone proves much more durable under heavy traffic than others, and that such local conditions as the effect of frost, the amount of rainfall and of sprinkling have an important influence. But none who carefully study macadam streets about a city suburb, or better still, upon a much traveled highway where the traffic follows parallel lines, can fail to appreciate the rapid wear that takes place on even the best macadam roadways. The result is that only for a few months while such a road is new is it in first-class condition.

In Jersey City a few days ago the Street and Water Board adopted a resolution directing their Chief Engineer to prepare no more specifications for macadam pavements until further notice. The reason for this action is given by the Jersey City "Journal" as follows:

> This action is the outcome of careful deliberattion on the part of the Commissioners, and is due to their conviction that macadam pavements in this city have not been a paying investment. They have not lasted long enough. They are not practical, it is claimed, for a city with so much heavy traffic as has Jersey City.
>
> Arlington, Bayonne and Garfield Aves. were macadamized only recently. Already those thoroughfares have been so badly cut up by heavy trucks that the Street and Water Board last week had to pass an ordinance to prohibit the passage of heavy vehicles on those streets unless provided with wide tires.

The fact of the rapid wear of macadam roads has led to various suggestions to improve them by embedding lines of rails in their surface. We reviewed various schemes of this class in our issue of May 7, 1896. As we then pointed out, there are numerous difficulties in the way of such schemes.

What appears to us a much more hopeful plan for an improved highway construction has recently been tried at Monmouth, Ill. It consists, briefly, of a combination of brick pavement and macadam road. The accompanying cut (Fig. 1) shows a cross-section of this road taken from the "Monmouth Daily Review," from which we take also the following particulars as to the method of its construction:

> The ground was prepared for it by grading and being allowed to stand for two months. It was treated to an occasional scraping so that it would pack evenly, and when the contractors were ready to lay brick it was as hard and even as a floor.
>
> The first thing was setting the curbing. This was made of 2×6 in. oak plank, set 7 ft. apart, and held by oak stakes 18 ins. long, and put down every 4 ft. Inside this was put a 5-in. bed of sand. This was evened up and the single course of No. 1 paving brick, made by the Galesburg Paving Brick Co., was put down. They were set on edge, and make a fine roadbed. Outside the curb 2 ft. of the crushed rock was laid, graded up to make an easy approach. This makes a road 11 ft. wide, and the finest in the land. The earth road on each side was graded and worked, making it in all 40 ft. wide and affording tracks on each side for use in dry weather.

We learn further that 3,000 ft. in length of this road was built during the past season. The contractors, Brodine & Dungan, who did the work, received for it $2,650 or 88.3 cts. per ft. The ordinary macadam roads in the same locality, 9 ft. in width, cost 70 cts. per ft., and have to be made with the country limestone of the vicinity, as harder stone is not available. Under these circumstances it may well be believed that the brick roadway will show great superiority over the stone roads.

But it seems to us that this new departure is of interest to other sections besides those where good macadam is not to be had while paving brick are cheap. Would not the laying of a strip of brick paving in the center of almost any macadam road be an improvement worth at least careful consideration?

The much easier traction upon the brick would not only be in itself a benefit to those using the road, but would cause the traffic to follow it almost entirely, especially the loaded wagons, which effect the most wear and do the most injury to a macadam road.

But in localities where there is a long freight haul on paving brick, the expense of even a 7 ft. strip of brick in a road might be prohibitory. In such localities the scheme is worth considering, it appears to us, of laying two parallel narrow strips of paving brick through the middle of a macadam road, as illustrated in the accompanying cross-section. These strips might be 16 to 20 ins. in width and of such gage that vehicles of all classes could follow them as they would a line of rails. The decreased traction on such a surface would be practically as great as if steel rails were laid in the macadam, as has been proposed, and if properly laid they would wear a very long time under any traffic where a macadam road is justifiable at all.

The details of construction, such as the foundation under the bricks, the construction of the macadam at their sides and between them, the filling between the bricks, etc., would vary with local circumstances and with the teachings of experience; but they need not be considered in a study of the merits of the scheme generally.

It appears to us that this combination of brick and macadam is the most promising plan for the improvement of suburban streets and country roads of heavy traffic that has appeared in a long time, and deserves consideration by every engineer who has to do with macadam roads. There are thousands of miles of city streets where the abutting owners can ill afford the assessments for the cheapest of block or asphalt pavements, and on the other hand the traffic is such that the maintenance of present macadam streets is a heavy burden. Cannot the needs of such cases be met by placing a brick roadway in the middle of the street and covering all the rest of the width between curbs with broken stone?

Again, there are thousands of places where a short piece of roadway is subjected to a very heavy traffic. Such roads occur around factories, mills, mines, quarries, railway stations and many other places. In many of these places an ordinary dirt road is in use, and teams are hauling over it loads not one-fourth as large as they could haul over a hard surface. In many other cases stone roads have been laid and are effecting a great saving over the old dirt roads, in cost of haulage, but are expensive to keep in repair under the heavy loads that pass over them. For such places as this the plan of using paving brick to take the heavy wear appears to be especially advantageous, and deserving of extended adoption.

It may be pointed out also in this connection that such a strip of brick pavement as is here proposed would make an admirable road for cycling, and the influence of that important body of agitators for road improvement might well be exerted in favor of this proposition.

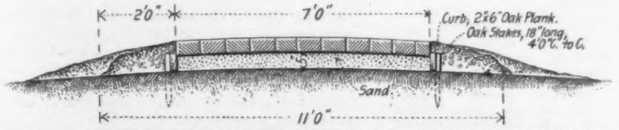


FIG. 1.—CROSS-SECTION OF COMBINED BRICK AND MACADAM ROADWAY AT MONMOUTH, ILL.

Designed by J. E. Miller, Engineer and County Surveyor; Brodine & Dungan, Contractors.

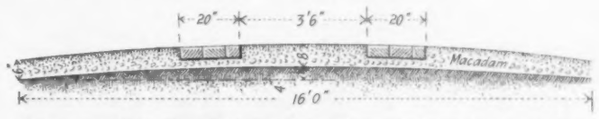


FIG. 2.—CROSS-SECTION OF PROPOSED 16-FT. MACADAM ROADWAY WITH PAVING BRICK TRACKWAY IN CENTER.

LETTERS TO THE EDITOR.

Corrections for Vertical Curves.

Sir: In setting the type for the "Table of Corrections for Vertical Curves," given on page 346 of your issue of Nov. 26, the printer got the decimal point in the wrong place in column headed 250 for algebraic differences of grades of 1.1 to 1.8, inclusive. Instead of 0.2, 0.3, 0.4, etc., the types should have read .02, .03, .03, .03, .03, .03 and .04. Yours truly, J. C. Nagle.

College Station, Tex., Dec. 2, 1896.

(A proof of the table referred to was sent to Prof. Nagle and returned without this error being noted. Accidents like this will happen in spite of all precaution, but are none the less annoying when they do occur.—Ed.)

Concerning Skew Arches.

Sir: In Engineering News of Oct. 22, in a criticism upon my work on "Segmental and Elliptical Oblique and Skew Arches," I am astonished to find that your reviewer has completely overlooked the very things he says "is the only part that would warrant a new treatise on a rarely applied art; in this country at least."

If the reviewer will kindly look at Plate I. again, he will find the very templates he asks for, given in what some think profuse detail, with the mode of applying them clearly illustrated, and their construction fully described in chapter 3, page 7; and in chapter 5, page 12.

he will find full and complete instructions as to the use and application of every template given on Plate I.

Yours truly, George Joseph Bell,
County Surveyor & Bridge Master.

Carlisle, England, Nov. 13, 1896.

(In justice to Mr. Bell it is admitted that our reviewer did overlook the text and illustrations referred to; and the only excuse for so doing is the limited treatment of both. To an expert, familiar with the detail described, they are doubtless sufficient; but it is still contended that for use in this country, where few have any practical knowledge of skew arch construction, the author would have made a more useful book had he been fuller in this part of his text and given more detailed dimensions to his illustrations of templates. With this exception, however, it is undoubtedly the best, as it is the latest treatise on this art.—Ed.)

Moment Tables for Cooper's Specifications.

Sir: The following is a table of moments and shears calculated for the locomotives given in the 1896 Specifications of Mr. Theodore Cooper. Their accuracy may be easily tested by noting that the moments, or shears, about corresponding concentrations of any two systems are in the same ratio as the numbers 27, 30, 35 or 40 of these systems.

Yours truly,
John H. Sayres.

Brooklyn, N. Y., Nov. 6, 1896.

Moment Tables for Cooper's 1896 Specifications of Railway Bridges.

	Wheel.	Distance.—Betw'n drivers, ft.	Distance.—From head train, ft.	Class E 27.—Shear at n — th wheel.	Class E 27.—Moment ab't (n + 1) wheel.	Class E 30.—Sheer at n — th wheel.	Class E 30.—Moment ab't (n + 1) wheel.	Class E 35.—Sheer at n — th wheel.	Class E 35.—Moment ab't (n + 1) wheel.	Class E 40.—Sheer at n — th wheel.	Class E 40.—Moment ab't (n + 1) wheel.
1st engine.	Pony	8	8	13,500	108,000	15,000	120,000	17,500	140,000	20,000	160,000
	First driver	5	13	40,500	310,500	45,000	345,000	52,500	402,500	60,000	460,000
	Second driver	5	18	67,500	648,000	75,000	720,000	87,500	840,000	100,000	960,000
	Third driver	5	23	94,500	1,120,500	105,000	1,245,000	122,500	1,452,500	140,000	1,660,000
	Fourth driver	9	32	121,500	2,214,000	135,000	2,460,000	157,500	2,870,000	180,000	3,280,000
	First tender	5	37	139,050	2,909,250	154,500	3,232,500	180,250	3,771,250	206,000	4,310,000
	Second tender	6	43	156,600	3,848,850	174,000	4,276,500	203,000	4,989,250	232,000	5,702,000
	Third tender	5	48	174,150	4,719,600	193,500	5,244,000	225,750	6,118,000	258,000	6,992,000
	Fourth tender	8	56	191,700	6,253,200	213,000	6,948,000	248,500	8,106,000	284,000	9,264,000
2d engine.	Pony	8	64	205,200	7,894,800	228,000	8,772,000	266,000	10,234,000	304,000	11,696,000
	First driver	5	69	232,200	9,055,800	258,000	10,062,000	301,000	11,739,000	344,000	13,416,000
	Second driver	5	74	259,200	10,351,800	288,000	11,502,000	336,000	13,419,000	384,000	15,336,000
	Third driver	5	79	286,200	11,782,800	318,000	13,092,000	371,000	15,274,000	424,000	17,456,000
	Fourth driver	9	88	313,200	14,601,600	348,000	16,224,000	406,000	18,928,000	464,000	21,632,000
	First tender	5	93	330,750	16,235,350	367,500	18,061,500	428,750	21,071,750	490,000	24,082,000
	Second tender	6	99	348,300	18,345,150	387,000	20,383,500	451,500	23,780,750	516,000	27,178,000
	Third tender	5	104	365,850	20,174,400	406,500	22,416,000	474,250	26,152,000	542,000	29,888,000
	Fourth tender	5	109	383,400	22,091,400	426,000	24,546,000	497,000	28,637,000	568,000	32,728,000

The Accident to the Painter's Scaffold on the Brooklyn Bridge Station.

Sir: Your editorial in issue of November 19th with reference to a damage suit resulting from an accident in the erection of the New York terminal of the New York and Brooklyn Bridge, in that it supposes carelessness on the part of the contractors "taking things for granted," requires, in our opinion, an answer, and the further inference that this hook broke off short under a static load was not proved to be the case. In fact we think very few engineers could study the circumstances attending the case and arrive at that conclusion.

In the first place, similar cornice hooks, made of the same shape, from iron of the same size (1¼ ins. diameter), obtained from the same source, had been used on the building, having been tested previously to being put in use, and their continued use, as well as tests made after the accident on one of these hooks, "showed that the shape and dimensions of the hook were sufficient." The evidence produced in the trial of the case shows that when the scaffold fell to the roadway, one of the cornice hooks remained hung in the gutter at the eaves, but the falls by which it was secured to the scaffold over-reeved and the line ran entirely through the blocks. It was also shown that this end of the scaffold had been secured to the side of the building by a light hand line, fastened to an eye-screw, which had been screwed into the woodwork, to keep the scaffold from swaying, and that a corresponding hand line at the other end of the scaffold was in process of being so secured. The second cornice hook was lying in the street, broken in three pieces, with the falls intact. It was also shown in the trial that an eyewitness had seen the end of the scaffold at which the falls ran out, descend first, that the fall at a certain point was checked temporarily when the other end, at which the cornice hook was broken, fell, the whole scaffold then dropping to the street. This evidence points very conclusively to the fact that the workman who was killed had failed to properly secure the falls intended to be used for raising and lowering the scaffold at his end, and that after it had become loose and fallen a few feet, the hand line used to secure this end of the scaffold to the side of the building came into play, retarding the fall of this end, at the same time upsetting the scaffold laterally, and throwing the cornice hook at the other end out of the gutter, which hook, falling to the street, was broken in three pieces, as stated above.

No attempt is here made to deny the fact that the iron in this hook was either cold-short or had been overheated in its original manufacture, but we do deny that the use of double refined iron, 1¼ ins. in diameter, known to have been procured from a reputable firm, and carefully tested and inspected under a rigid specification for high test iron, was unduly "taking things for granted."

That the jury gave a verdict for the plaintiff shows simply that their sympathy was stronger than their ability to appreciate the facts which were originally responsible for the loss of life, but does not disprove them.

Yours respectfully, Levering & Garrigues.

552 and 554 West 23d St., New York, Dec. 1, 1896.

The Advantages of a Tunnel for the Newtown Creek Crossing.

Sir: The communication from Mr. Albert H. Scherzer, published in your issue of Dec. 3, 1896, calls attention once more to the problem which the authorities of Kings and Queens Counties have before them for solution; namely, how best to carry the highway traffic across Newtown Creek from Vernon avenue, in Long Island City, to Manhattan avenue in Williamsburgh. Mr. Scherzer points out very clearly the elements of the situation and the absurdity of bridging the river at the present level of the street, and his arguments if carried to their logical conclusion seem to the writer to indicate that a tunnel would be the only complete solution of the problem. With viaduct approaches and a bascule bridge which must be lifted for a portion of the river traffic any way, the problem is yet incompletely solved, but a tunnel under the Long Island R. R. tracks and the river would provide for continuous, safe and uninterrupted travel at all times, both by land and water.

On July 23, last, Mr. Frank Miller and the writer presented to the Newtown Creek Bridge Committee a design for such a tunnel and an approximate estimate of its cost, accompanied by a brief description of its main features and advantages, the substance of which you published in connection with various bridge designs in your issue of Nov. 5, 1896. We pointed out that a tunnel of ample capacity could be constructed without using prohibitory grades, that the railroad tracks would thereby be crossed below grade, that the cost of maintenance would be very small compared to the cost of maintaining and operating any kind of a bridge, that travel would be absolutely uninterrupted both by land and water, and that considerable dock space would be made available which is not so now.

Matters have progressed so far now that the Bridge Committee does not of course consider the question open for discussion. But to the citizens and taxpayers who are to foot the bills and suffer the consequences, the problem will always be open for discussion until actually solved. Suppose at the coming session of the Legislature a law should be passed abolishing all grade crossings in the State of New York; with a new bridge at the present street level, it would be rather awkward either to elevate or depress the highway sufficiently in a distance of 250 ft. to make a satisfactory crossing. On the other hand the expense of elevating or depressing the tracks would be a serious matter for the railroad company, involving a change of elevation of the yards and terminal. To avoid the former the municipal governments could increase their present bridge appropriation to an amount sufficient to build a tunnel under both river and railroad, now, once for all; to avoid the latter the railroad company could augment the present appropriation to an amount which would be sufficient to build the tunnel. The Long Island R. R. people would no doubt willingly contribute substantially to a scheme reducing their liability to accidents and relieving them from the running expense of guarding a dangerous crossing.

But this is not all. As Greater New York becomes greater and other East River bridges are completed, travel along the water front will increase with the natural increase of business, and will follow the line of least resistance. This route should be made the line of least resistance in the interest of property in the manufacturing district of Williamsburgh and in the business portion of Long Island City. The street railroad companies whose cars now wait sometimes half or three-quarters of an hour at a time for the opening and closing of the drawbridge, and have an additional wait at the railway crossing, ought willingly to make a substantial contribution to a plan by which their traffic would be continuous and uninterrupted at all times. The situation is now and has been for some time, such that a man whose business requires him to make the trip from Long Island City to Williamsburgh within a limited time cannot depend upon this route at all. The 23d St. & Greenpoint Ferry carries considerable traffic which geographically belongs to the Long Island City & 34th St. Ferry, but does not take the shortest route on account of the uncertainty of this Vernon Ave. crossing to Williamsburgh. This state of affairs will not be materially improved by putting any kind of a new bridge in place of the old one. Besides this, the shipping interests ought to be considered, since the business of the locality is as much affected by the interruption of the water traffic as by that of the land traffic.

Taking it all in all, the writer ventures to say that a careful investigation and comparison of all the solutions of this problem thus far proposed, will show that a tunnel, if properly financed, offers the best and most satisfactory return in the long run for the capital invested.

Yours truly,
Wm. W. Crehore, Assoc. M. Am. Soc. C. E.

New York, Dec. 8, 1896.

Proposed Standard Specification for Portland Cement.

Sir: In view of the article by Mr. Lesley published in your issue of Sept. 24, which criticises the proposed specification for Portland cement advanced by the writer, it appears necessary that a few further facts be brought out to place this discussion in its proper light before the public and define the position assumed by me in advocating such a specification.

I again reiterate the assertion that the requirements of the American Society of Civil Engineers are indefinite and inadequate, and what engineer who has had experience in the testing of cements will not bear me out? What public testing laboratory follows all the requirements and is governed by the recommendations of the American Society of Civil Engineers? Take for instance the provision into which the personal equation of the operator enters so largely for filling the molds with mortar or cement. In this country we have no apparatus like Dr. Bohme's hammer which regulates the amount of pressure exerted in forcing the cement into the molds. It is a well-known fact that the results of cement testing are governed largely by the skill of the operator and the locality of making the tests. Laboratory tests are more accurate and show more nearly the true value of a cement than tests made on the work.

Could any of the distinguished engineers enumerated by Mr. Lesley answer the question he propounds, whether the construction of colossal bridges, buildings, reservoirs, aqueducts and tunnels, railways, etc., since June 21, 1895, has been done with cement of second grade?

Mr. Lesley seeks to draw the attention of these engineers to the assertion made by the writer that the American Society's specifications are indefinite and inadequate, by insinuating that the work was improperly done with second grade cements. In the first place, this question is most ridiculous on its face. What bearing can it have on the question at issue, Portland cement specifications? Surely no engineer would be rash enough to attempt an answer. Has all the above mentioned engineering work been done with Portland cement? Supposing it has, in order to support Mr. Lesley's question, has all the cement been tested? Here are two facts which should be known before any engineer could attempt an answer. Assuming that Portland cement was used and tested, it is a fact, even Mr. Lesley must admit, that "second grade" cement would pass if such a requirement as a neat tensile strength of "300 to 350 lbs." were used, which he says "will give good results." The second grade Portland cements made by other manufacturers besides Mr. Lesley are guaranteed to stand 300 lbs. neat in seven days. However, the absurdity of such a question is apparent when it is generally known that a large part of all the large engineering work done in this country in the past 11 years was constructed of so-called American cements (Rosendales and "Improved" cements) while a very small percentage of the Portland cement used was tested. Where specifications do exist, notably on railway work, the testing is not always carried out scientifically; the requirements may be there, but the cement is not systematically tested to see if it passes the limits. This is certainly the case with the railways cited by Mr. Lesley and whose requirements will be found about what he thinks give good results. On the other hand the higher requirements are those on municipal work where the testing is more thorough and exacting.

Now taking up in detail the 21 specifications, giving the requirements for tensile strength only, which he cites as from leading engineers in this country and wherein his

last article says they are not refuted. The first, second, nineteenth and twentieth should be thrown out and not considered at all, for they give arbitrary values for the U. S. Govt. Lighthouse Engineers and Army Engineers, as though all offices had the same requirements. All of the railways come under the remarks made above and show low requirements, while the rest are those from cities and being used on municipal engineering, the testing is more rigid while the requirements are higher.

In first class cities, well equipped laboratories are to be found, either public or connected with the cities' departments of public works, which test and inspect cement to be used on work in their vicinity. On the other hand railways, especially those quoted by Mr. Lesley, have no laboratories where competent persons are employed to test cements. In the first case the requirements must be low or, with the inexperienced operator, the very best cements would not pass the tests; while on the other hand, tests made by laboratories obtain all there is in the cement and would allow a second grade cement to pass a low specification.

From the specifications quoted below, with the names of the engineers and architects and structures for which the cement was used in this city, it will be seen that the requirements advocated by me are not novel or excessively high, as Mr. Lesley would lead your readers to believe. These specifications are in use on all the structures lately erected and in process of erection by the engineers and architects quoted, and were not made for any one piece of work. The cement manufacturers or dealers bid on them knowing the requirements and that all the cement was to be tested at a laboratory.

Frank Miles Day & Bro., Philadelphia, Pa.

Buildings—Houston Hall (University of Pennsylvania), Horticulturel Hall, Medico-Chi College Amphitheatre, American Baptist Publication.

Specifications:
Chemical Composition—The Cement must show less than 2% of sulphuric acid, and less than 2½% of magnesia.
Fineness—95% shall pass a sieve of 4,900 meshes per sq. in.
90% shall pass a sieve of 10,000 meshes per sq. in.
68% shall pass a sieve of 40,000 meshes per sq. in.
Checking, Cracking and Color.—Three cakes of neat cement are to be molded on glass 2 or 3 ins. in diameter, and about ½ in. thick at the center, the edges being very thin. These cakes are to be made from a mixture of the cement and water to the consistency of a stiff plastic mortar.
Cake No. 1 is to be left in the air for the determination of color. The color must be uniform throughout, of a blueish or greenish gray for Portland, and the cake must be free from yellow blotches. The cake must show no signs of cracking or distortion after being kept indefinitely.
Cake No. 2 is to be put in cold water as soon as set stiff enough for the purpose, and to remain there two or three days, when it will be put in water at 200° F. and kept there for 24 or 48 hours. At the end of this time the cake should show no signs of cracking, swelling, blowing or distortion.
Cake No. 3, when hard enough, is to be placed in water and examined from day to day, to ascertain if it becomes contorted, or if cracks show themselves at the edge.

	7 days.	28 days.
Tensile strength—Neat cement.....	500 lbs.	600 lbs.
Mortar, 3 to 1....	150 "	250 "

G. W. & W. D. Hewitt, Philadelphia, Pa.

Building—Philadelphia Bourse.
Specifications:
Fineness—85% shall pass a sieve of 10,000 meshes.
70% shall pass a sieve of 40,000 meshes.
Expansion and contraction—A pat of neat cement as soon as it is set, to be submitted to a moist heat and immersed in boiling water for at least 10 hours and must not show any signs of blowing.

	7 days.
Tensile strength—Neat cement.....	400 lbs.
Mortar, 3 to 1.....	150 "

Westray Ladd, Philadelphia, Pa.

Building—Newsboys' Evening Home.
Specifications:
Fineness—90% shall pass a sieve of 10,000 meshes.
70% shall pass a sieve of 40,000 meshes.
Checking and Cracking—A pat of neat cement as soon as set hard to be placed in steam vapor for three hours and afterwards immersed in water at 200° F. for 10 hours, when it must show no signs of swelling or cracking.

	7 days.
Tensile strength—Neat cement.....	500 lbs.
Mortar, 3 to 1.....	150 "

Jos. M. Houston. Philadelphia, Pa.

Building—Presbyterian. t
Specifications:
Composition—All cement must show less than 2% of sulphuric acid, and less than 2.5% of magnesia.
Constancy of Volume—The cement must be mixed with pure water to obtain a stiff mortar and made into pats 3½ ins. in diameter, ⅝-in. thick at the center, and drawn to sharp edge at the circumference. The cement must show no signs of discoloration, cracks or distortions after an indefinite length of time, and after properly set to be placed in cold water for two days and then put in water at 200° F. for 24 hours, and must show no signs of cracking, swelling, blowing or distortion.

	7 days.	28 days.
Tensile strength—Neat cement.....	500 lbs.	600 lbs.

P. W. Roos, New York, N. Y.

Building—Mutual Life of New York (10th and Chestnut Sts., Phila., Pa.)
Specifications:
24 hours.—Tensile strength..... .....7 days
300 lbs.—Neat cement..... .....500 lbs.
3 sand to 1 cement.....150 "
Constancy of Volume—A pat of neat cement as soon as set hard to be placed in steam vapor for three hours and afterwards immersed in water 200° F. for 10 hours, when it must show no signs of swelling or cracking.

Wilson Eyre, Jr., Philadelphia, Pa.

Building.—City Trust & Safe Deposit Co.
Specifications.—Same in all requirements as those of F. M. Day & Bro.

Edgar V. Seeler, Philadelphia, Pa.

Building.—Dental Hall (University of Penna.)
Specifications.—Same in all requirements as those of F. M. Day & Bro.

F. M. Day & Bro., Cope & Stewartson, Wilson Eyre, Jr. (Asociated Architects).

Building.—Archaeological Museum (University of Penna.)
Specifications.—Same in all requirements as those of F. M. Day & Bro.

In all the above specifications the requirement for setting was omitted, as Mr. Lesley does not criticise that provision, while the other requirements are given in full. The general conditions governing the tests are the rules of the American Society of Civil Engineers.

Now from a summary of the foregoing specifications it will be seen that in the chemical composition the requirement for sulphuric acid is the same as advocated by me while the magnesia is ½% lower. The requirements for fineness are all slightly lower, while with one exception the tensile strengths are equal to those advocated by me. Now as to the requirements for checking and cracking, one requires a temperature of 212° F., while all the rest call for 200° F. Thus it will be seen that with the exception of the fineness and percentage of magnesia, which I shall discuss later on, the requirements are about the same as in the specifications he describes as "crude and ill digested." Would the gentlemen I have quoted, among the leading men in the profession in this city, feel flattered were they to realize that their specifications are "crude and ill digested?" Lastly, I think the following will totally disprove what Mr. Lesley would have your readers believe, that the tendency is towards lower requirements and that with such high requirements even the best imported cements would fail. The brands of cements going into each piece of work with the laboratories testing the same, which it is to be presumed passed the requirements, I now give in case Mr. Lesley has not heard of them.

Houston Hall Building; Atlas, Alsen & Heyne cement; Lathbury & Anderson laboratory.
Horticultural Hall Building; Mannheimer & Vorwohler cement; Lathbury & Anderson laboratory.
Medico-Chi College Building; Aalborg cement; Lathbury & Anderson laboratory.
American Baptist Building; Condor cement; Lathbury & Anderson laboratory.
Bourse Building; Alpha cements (foundations and brick work), Mannheimer & Dyckerhoff cement (pavements); Lathbury & Anderson, and Booth, Garrett & Blair laboratories.
Newsboys' Home Building; Alpha cement; Lanbury & Anderson laboratory.
Presbyterian Building; Alpha, Condor and Vulcanite cements; Booth, Garret & Blair laboratory.
Mutual Life of New York Building; Alpha cement; Lathbury & Anderson laboratory.
City Trust Building; Aalborg cement; Lathbury & Anderson laboratory.
Dental Hall (University of Pa.) Building; Condor, Atlas and Dyckerhoff cements; Lathbury & Anderson laboratory.
Archaeological Museum Building; not selected; Lathbury & Anderson laboratory.

So much for specifications on private work, and with the following specifications for three large pieces of public work for the year 1896, it must be admitted that my specifications are not radically high in their requirements.

Department of Public Works, Brooklyn, N. Y., Wallabout Improvement.

Composition and Ingredients.—All the cement shall be composed of lime, silica and alumina in their proper proportions, be as free as posible from all other substances and contain no adulterant in injurious proportions. The ratio of the weight of silica and alumina to the weight of the lime in the cement shall not be less than 45-100. The cement shall not contain more than 3% of magnesia nor more than 1% of sulphuric acid.
Fineness.—99% shall pass through a sieve of 2,500 meshes; 90% shall pass through a sieve of 10,000 meshes; 70% shall pass through a sieve of 40,000 meshes.
Soundness.—All the cement must be sound in every respect and show no indications of distortion, change of volume or blowing when subjected in the form of pats to exposure in air and fresh and sea water of temperature (from 60° to 212°, as follows:
The pats will be made of neat, unsifted cement, mixed with fresh water to the same consistency as stated for briquettes, and will be about 3 in. in diameter, having a thickness at the centre of about ½ in., tapering to about ⅛ in. at the edges. They will be molded on plates of glass and kept thereon during examination.
(a) One or more of these pats will when set "hard" be placed in fresh water of temperature between 60° and 70° for from 1 to 28 days.
(b) One or more of these pats will be allowed to set in moist air at a temperature of about 200° for about three hours. It will then be placed and kept in boiling water for a period of from 6 to 24 hours.
(c) One or more of these pats will be allowed to set in moist air at a temperature of about 100° for three hours; it will then be placed and kept in water of a temperature of 110° to 115° for a period of from 24 to 48 hours.
(d) One or more of these pats may be subjected to any or all of the above indicated tests (a, b and c), using sea water instead of fresh water.
(e) One pat will be kept in the air for 28 days and its color observed, which shall be uniform throughout, of a bluish gray and free from yellow blotches.
A failure to pass test "b" will not necessarily cause the rejection of the cement, provided it passes the other tests for soundness as noted in "a," "c," "d," and "e," and is satisfactory in other respects to the engineer.

Tensile Strength.—Mixed neat with about 25% of water by weight and worked to stiff plastic paste. Mixed with three parts sand by weight and about 12% of combined weight of sand and cement of water to stiff plastic paste.

	24 hours.	7 days.	28 days.
Neat	150 lbs.	400 lbs.	600 lbs.
Mortar, 3 to 1.....		150 "	240 "

Board of Public Works, Reading, Pa.—Department of Sewers.

Composition.—Magnesia, not over 2½%; sulphuric acid, not over 2%.
Fineness.—95% shall pass through a sieve of 10,000 meshes; 80% shall pass through a sieve of 40,000 meshes.
Checking and Cracking.—Two cakes of neat cement to be molded on glass. One to be immersed in cold water, after having set hard, and examined from day to day for surface checking and warping, the other after having been set hard to be immersed in water at 212° F. and allowed to remain in water of that temperature for 24 to 36 hours. Examination of the pat at the end of that time for constancy of volume and checking. Should the pats become contorted or show signs of warping or cracking, the cement will be rejected.

Tensile strength.	24 hours.	7 days.	28 days.
Neat	200 lbs.	500 lbs.	650 lbs.
Mortar, 3 to 1...		150 "	250 "

Department of Public Works, Philadelphia, Pa.—Bureau of Water.

Tensile strength.	24 hours.	7 days.	28 days.
Neat	200 lbs.	550 lbs.	650 lbs.
Mortar, 3 to 1...		200 "	300 "

Hot Water Tests.—All cement shall meet such other additional requirements as to hot water, set and chemical tests as the engineer may determine, the requirements for set may be modified where the conditions are such as to render this advisable.

The Portland cement furnished under the above specifications was used in large quantities for concrete work. In Brooklyn the work consisted in the improvement of the Wallabout Market lands under the direction of Mr. W. E. Belknap, engineer, Atlas cement being used. The Reading, Pa., work consisted of the entire concrete sewer system under the direction of Mr. E. Chamberlain, City Engineer, Atlas cement being used. The Philadelphia specifications embraced the large work on the Queen Lane reservoir, under the direction of Mr. Jno. C. Trautwine, Chief Engineer of the Water Bureau, Alpha cement was used on one section.

A careful study of the above specifications will show Mr. Belknap's to be the same in magnesia and sulphuric acid as I recommend; tests for fineness and tensile strength slightly lower, while the requirements for soundness are much more severe than I recommend. It is to be noted especially under the heading "Soundness," paragraph (b), Mr. Chamberlain's requirements are the same as mine, with the exception of magnesia, in which he is ½% lower. Mr. Trautwine's tensile requirements are higher in both neat and mortar tests for 7 and 28 days than those I recommend.

The above specifications will certainly show that Mr. Lesley in his aim to convince your readers that the tendency is towards lower requirements, has only picked out those specifications which support his criticisms. Now is this a scientific way of criticising this subject? The specifications I have exhibited show some lower and some higher than those I have advocated.

Another point that Mr. Lesley makes in his article of Sept. 21st: He states that "Not a single specification is refuted by Mr. Donaldson, nor its accuracy questioned."

Having assumed they were correct, I did not go over them carefully and consequently made no reference to them in my answer to his first criticism; but I would like now to correct the 7-day neat requirements of both Russia and Belgium from 255 lbs., as stated by Mr. Lesley, to 355 lbs.; to insert a 7-days sand test for France of 113 lbs. and to correct the 28-days sand test from 215 lbs., as stated by Mr. Lesley, to 213 lbs.

Under Mr. Lesley's list of the different countries, giving the requirements for fineness, Roumania is to be found. Now under the list giving the requirements for strength, Roumania is left out, while all the other countries appear. Why is this? It may be well to enlighten the "inexperienced engineers and architects." Under the same government specifications quoted by Mr. Lesley for fineness are the tensile requirements for sand test (3 sand to 1 cement) at 7 days of 142 lbs. and 28 days of 241 lbs.; no neat test being required. It might be well to mention the fact (Mr. Lesley having overlooked this also) that the government of the Roumanian railways requires a tensile strength for the 3 to 1 sand test of 213 lbs. at 7 days and 284 lbs at 28 days, without neat requirements; the latter being higher than any specification quoted by the writer and almost equal at 28 days to the neat requirement of 300 lbs. at 7 days, which Mr. Lesley "thinks will give good results." The requirement of Russia mentioned by Mr. Lesley as 142 lbs. for 28 days sand test, being the lowest of all the continental countries, would also bear an explanation. In all the countries, with the exception of Russia, the normal sand for making sand briquettes passes a sieve of one mesh and is caught on a sieve of another mesh the same as by the Am. Soc. C. E. rules. In Russia the normal sand consists of one part which passes a sieve of 64 meshes per sq.cm. and is caught on a sieve of 144 meshes per sq. cm., and one part which passes a sieve of 144 meshes per sq. cm. and is caught on a sieve of 225 meshes per sq. cm. Thus it will be seen that the normal sand consists of equal parts fine and coarse particles, hence the low requirement.

The facts above stated disprove entirely Mr. Lesley's attempt to convince your readers that the requirements advocated by me are abnormally high and above any others ever used on engineering work; and prove that the general tendency is not towards lower requirements; and that his specifications, as quoted, are inaccurate and misleading.

Mr. Lesley apparently loses sight of the main reason which influenced the writer in preparing the paper published in part in your issue of July 16. In the first place the prime object in writing that paper was to urge the adoption by the U. S. Government of a standard specification for Portland cement and a specified method of testing, which would be applicable to all departments alike. Such a standard, if adopted by this government, would prove beneficial to both users and producers alike; and at the same time would be used outside of government work. In presenting this subject, care was taken to collect specifications from as many offices in the several departments as could be obtained, in order to present the conditions as they now exist and argue from them the need of some such measure in this country. The majority of the European countries have their government specifications, while the United States has not and the defective system was explained in the paper acompanying the specifications prepared by me. The subject was not taken up before the conditions were carefully studied. It was not the purpose to antagonise either the United States Engineers on the one hand, or the cement industry, as championed by one man, on the other. In all some 30 odd specifications were collected, which it would have been

Tensile Strength.

	Neat.			3 sand to 1 cement.		
	24 hrs.	7 days.	28 days.	7 days.	28 days.	6 mos.
No. 1.	300[1] lbs.	450 lbs.	700 lbs.	... lbs.	... lbs.	... lbs.
No. 2.	.. "	400 "	... "	125 "	200 "	... "
No. 3.	.. "	... "	... "	125 "	200 "	350 "
No. 4.	.. "	430 "	500 "	120 "	180 "	... "
No. 5.	250 "[1]	450 "[1]	... "	... "	... "	... "
	... "	400 "	600 "[2]	125 "	200 "[2]	... "
No. 5.	200 "[1]	450 "[1]	... "	... "	... "	... "
	... "	450 "	600 "[2]	125 "	200 "[2]	... "
No. 6.	250 "[1]	400 "	600 "[2]	125 "	200 "[2]	... "
No. 7.	.. "	450 "	... "	140 "	... "	... "
No. 8.	.. "	1,100 "	... "	... "	... "	... "
No. 9.	.. "	550 "	... "	... "	... "	... "
No. 10.	.. "	500 "	... "	... "	... "	... "
No. 11.	.. "	300 "	... "	80 "	... "	... "

[1]In air. [2]Thirty days.

Note—Under the heading Tensile Strength, two specifications are quoted for No. 5, the first was dated July 23, 1896, while the second for the same piece of work was dated Oct. 15, 1896. The rules for the testing are based generally on the Am. Soc. C. E. rules, while notation is made above for air tests. Specification No. 8 requires transverse and compression tests.

A careful analysis of these specifications will bring out clearly these two facts: First—That Mr. Lesley is wrong when he quotes the U. S. Engineers in your issue of Sept. 10, as having one requirement; Second—That he is wrong in stating that the tendency is towards lower requirements. It is ridiculous for Mr. Lesley to assert that my requirement of 500 lbs. neat at 7 days "would lead to dangerous results in work," and equally as absurd to state that "there is a marked swing in the pendulum in

of magnesia, as explained in your issue of Sept. 10, remains unassailed by Mr. Lesley; while the percentage of sulphuric acid, notwithstanding his futile efforts to twist the meaning of the two requirements, is precisely the same as universally specified. Admitting that the limits for lime and silica are somewhat confined for low limed cements, the limits for iron and alumina combined are the same as those within which M. Le Chatelier says "Portland cements of good quality are to be found" and from the analyses of M. Cardiot of the principal cements of France, England, Germany, Belgium and Russia (Ciments et Chaux Hydrauliques; Paris, 1891; pp. 71 and 76) the following number are within the limits advanced by me:

French, 11 out of 12 cements; English, 12 out of 13 cements; German, 10 out of 14 cements; Belgium, 6 out of 6 cements; Russia, 4 out of 7 cements. This certainly shows that a majority come within the limits specified by me.

Having only answered Mr. Lesley on the four headings he criticises the proposed specifications on, it certainly will be admitted by the readers of your paper that I have not only "found scientific support," but have produced the same in defending the requirements of my specifications. As to whether they are "crude and ill digested" as Mr. Lesley states, I leave that to the judgment of those of your readers who will carefully go over the facts and proofs presented in this paper in support of my specification and in disputing the arguments of Mr. Lesley.

Before concluding, I would like to bring out clearly a point which has not been considered by Mr. Lesley. The requirements are high and in formulating them it was

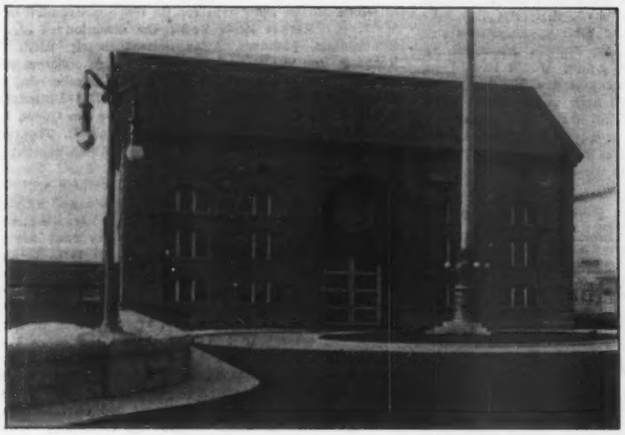


FIG. 1.—POWER HOUSE OF THE NIAGARA FALLS POWER CO.,—END VIEW.

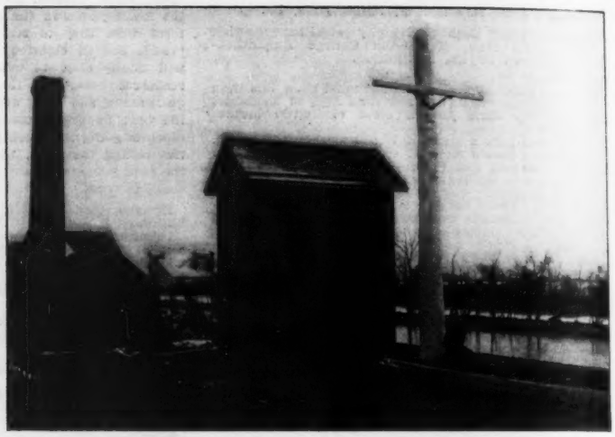


FIG. 6.—TERMINAL STATION AT CITY LIMITS OF BUFFALO, WHERE WIRES PASS FROM POLES TO UNDERGROUND CONDUITS.

impossible to have published in detail, but it is safe to say no two were alike. From some offices no specifications could be obtained, while others had none.

In order to show the varied character of the specifications as respects requirements for fineness, checking and cracking and tensile strength, a few are given below. No specifications received contained chemical requirements. The requirements correspond to the order in which the offices are given.

Departments and Offices.

No. 1.—U. S. Engr. Office, Washington, D. C.; Maj. E. L. B. Davis; August 14, 1895.
No. 2.—U. S. Engr. Office, Detroit, Mich.; Col. O. M. Poe, September 28, 1895
No. 3.—U. S. Engr. Office, Duluth, Minn.; Maj. E. B. Sears; January 28, 1895.
No. 4.—U. S. Engr. Office, Chattanooga, Tenn.; Capt. Dan C. Kingman; July 1, 1895.
No. 5.—U. S. Engr. Office, Philadelphia, Pa,; Maj. C. W. Raymond; July 21, and October 15, 1896.
No. 6.—U. S. Engr. Office, Newport, R. I.; Maj. D. W. Lockwood; August 25, 1896.
No. 7.—Rock Island Arsenal, Rock Island, Ill.; Col. A. R. Buffington July 22, 1896.
No. 8.—U. S. Navy Yard, Mare Island, Cal.; Capt. H. L. Harrison, Commandant; December 27, 1895.
No. 9.—U. S. Navy Yard, Norfolk, Va.; H. F. R. Harris, Paymaster; October 30, 1896.
No. 10.—U. S. Navy Yard, Washington, D. C.; Com. J. A. Howell, Commandant; December 24, 1895.
No. 11.—Office U. S. Light House Engineer, 5th District, Baltimore, Md.; Capt. Erick Bergland; August 22, 1894.

	Fineness.	Sieve meshes.	Checking and cracking.
No. 1.	95% through	4,000.	No requirement.
No. 2.	98% "	2,500.	Pat. subjected to st'm vapor
	75% "	14,400.	and immersed in hot water
No. 3.	75% "	10,000.	Pat. immers'd water 212° F.
No. 4.	87½ "	10,000.	Pat. immersed in cold water
No. 5.	No requirements.		No requirement.
No. 6.	" "		" "
No. 7.	95% through	2,500.	Pat. immers'd water 212° F.
No. 8.	90% "	6,400.	No requirement.
No. 9.	97% "	3,600.	" "
No. 10.	90% "	6,400.	" "
No. 11.	96% "	2,500.	Pat. immersed in cold water

favor of the elimination of the boiling test," when so many of the specifications cited by me require it.

Now, it is manifestly clear, from a study of the few specifications quoted above, wherein I have argued, in my "Proposed Standard Specification," for some uniformity among government engineers. It is likewise shown from the number of prominent specifications of government as well as civil engineers that the requirements advocated by me are not abnormally high or novel, as Mr. Lesley would have your readers believe.

In the matter of fineness, specifications certainly show that in the last five years this particular requirement has been raised, due to the gradual realization of its importance from the valuable results obtained, and why should it not be raised even higher? Perfect conditions can only be obtained by eliminating the coarser particles in a cement and thereby increasing the strength. All the advantages derived from fine grinding have been fully brought out in my previous papers, and writing as a manufacturer it is certainly within my province to judge of the capabilities of mills to meet such requirements as are advocated by me. Even Mr. Lesley is constrained to admit that "no careful manufacturer would hesitate to guarantee cement of the fineness he recommends." The whole question of fineness to a manufacturer hinges on the increased cost of production, and if such limits as these advocated by me were advanced by an engineer, Mr. Lesley would hardly raise objections. Certain it is, no consumer would be found among those who objected on the ground of an excessive requirement, for they would be the ones directly benefited. Should some prominent engineer, government or civil, specify limits as high as those advocated by me, it is certain that mills would soon grind fine enough to meet them. On this point also the objections of Mr. Lesley are to be read in two words "extra cost," and while it is admitted that the requirement in this respect is slightly higher than in the majority of specifications, it will not be very long before the requirements in many will equal them.

Taking up the remaining element criticised by Mr. Lesley, chemical composition, my authority for the percentage

the purpose to make them high, but to meet this not only a specific manner and method of testing was provided, but it was stated that testing should be done in well equipped laboratories, by competent persons, thoroughly conversant with the subject of cement in both its chemical and physical properties. Testing thus conducted would obtain maximum physical results and the best Portland cements would easily pass the requirements.

Yours very truly,

Wm. J. Donaldson.

503 Betz Building, Philadelphia, Pa., Nov. 12, 1896.

(The demands on our space compel us to rule the discussion on this subject closed with the above letter. Without reference to the special matters in controversy, it may be remarked that each of the parties to the discussion have contributed a large amount of information respecting the specifications for Portland cement in use in a great variety of places, which will be studied with interest, we doubt not, by those of our readers who have cement specifications to formulate.

We may remark as an interesting fact in this connection that at the meeting of the American Society of Civil Engineers, on Nov. 4, a resolution was adopted recommending to the Board of Direction of the Society to take action looking to the preparation of a new standard code for cement testing to replace the one formulated by a committee of the Society in 1884.

Under the constitution the Board will make its report at the next annual meeting, and that meeting may order a letter ballot of the Society as to whether the proposed action shall be taken. Doubtless, the Society, if it takes action, will merely revise its code governing the method of making tests, and will not attempt anything in the way of a standard specification.

It appears to us that the most important point raised by Mr. Donaldson is the desirability and expediency of the adoption of a standard cement specification by the Government or by the Corps of Engineers. Concerning this, it appears plain enough that good results might follow, for example, if the Chief of Engineers were to create a Board to formulate a standard cement specification for use by the various officers of the corps. In the multitude of duties with which an engineer officer is charged, few have time to study all the ins and outs of the subject of cement tests and specifications, and it would be a great aid to good practice, undoubtedly, to have a standard specification at hand, prepared by some of the ablest men in the Department. Such a specification, of course, would need to be very elastic, and would need to contain many alternative provisions from which each officer could select those best suited to his especial work. Cement for use in sea-water, for example, should have certain special requirements, and the most economical grade of cement to use for a given work will vary widely in different localities.

But while we can readily see the benefit of such a standard specification, we would also urge strongly that no action should be taken that would make such a standard specification difficult to change.

May the day be long distant when Congress shall enact a standard cement specification for use in all Government departments! Experience with the old U. S. standard for testing boiler-plate is an excellent illustration of the evil in getting a Government standard adopted in such shape that it cannot be readily amended and kept up with the times. For this reason we should strongly oppose Mr. Donaldson's proposition to have a single standard specification control all Government work. That could not be brought about without Congressional action, which is at all costs to be avoided.

If, however, the present able Chief of Engineers should see fit to appoint a Board to formulate some standard specification, the use of which should be recommendatory, not compulsory, upon the various officers of the Corps of Engineers, we can see how the action might be very beneficial. —Ed.)

Notes and Queries.

Frank A. Peirce, Greensboro, N. C., wishes to obtain the address of parties experienced in the construction of timber flumes for the transportation of timber. He also asks for any published data detailing the ordinary methods of construction.

THE NIAGARA FALLS AND BUFFALO ELECTRIC POWER TRANSMISSION.

Among the first corporations that contracted with the Niagara Falls Power Co. for electric current from the power house at the Falls was the Buffalo Street Ry. Co. In accordance with that contract there is now being delivered at Buffalo electric current sufficient to develop 1,000 HP. This current is sent over bare wires from the power house at Niagara Falls, a distance of 26 miles. The various power plants at Niagara Falls have been described from time to time in our columns, and are without doubt the most famous of all electric power installations by reason of the vast possibilities of future development.

FIG. 2.—VIEW IN THE INTERIOR OF THE NIAGARA POWER HOUSE, SHOWING THE THREE 5,000-H. P. WESTINGHOUSE DYNAMOS NOW RUNNING.

The current from the Falls is generated by the Niagara Falls Power Co., which transmits the power as far as the city limits of Buffalo. All the construction work in connection with this installation was effected by the Cataract Construction Co., while the distribution, after it has reached the city limits, is in the hands of the Cataract Power & Conduit Co.

The first dynamo of the Niagara Falls Power Co. was started on April 5, 1895, and contracts for power have now accumulated sufficient to absorb the entire output of the three 5,000 HP. generators which were first installed. Work is now in progress on an extension of the wheel-pit and power house which will permit additional dynamos to be placed.

Work on the line for transmitting electric current from Niagara to Buffalo was begun last August by the White-Crossy Co., of 29 Broadway, New York city, which has spared no expense to construct the line in as substantial and durable a manner as possible. The pole line is not a straight one; owing to the objections of land owners to having their farms cut in two, it was necessary to deviate considerably from a direct route, and for a large part of the distance the line follows the property boundary between farms.

For the greater part of the distance the company owns the right of way, a strip 30 ft. wide; for five miles the line runs along the bank of the Erie Canal. There were 21,000 poles required for the work. They are of white cedar, shaved round, and are to be painted. The poles vary in height from 35 to 65 ft., and in diameter from 15 to 30 ins. They are set at distances varying from 60 to 75 ft. in order to eliminate any sympathetic vibrations of adjacent sections of the wires. The holes for the poles were dug from 6 to 8 ft. deep, and wherever the earth was soft concrete was used in setting. At sharp curves six poles were set in pairs (Fig. 5), each pole supporting one end of a double cross arm. The double cross arms are used to distribute the weight of the wire on two insulators instead of one, and to make the turn less abrupt.

Each pole carries three cross arms. The two upper ones are to support the power cables; they are yellow pine, 12 ft. long and $3\frac{1}{4} \times 4\frac{1}{4}$ ins. in section. Each is trussed with an angle iron $1\frac{1}{2} \times \frac{1}{4}$ ins. Each cross arm is designed to carry six cables. At either end of the top cross arm is a steel pin 18 ins. high; along these pins and also on top of the poles will be stretched three barbed iron wires; these will be grounded at frequent intervals and are expected to give protection against lightning. The pin holes in the cross arms are 4 ins. deep with drainage holes. All pins were boiled in linseed oil. The third cross arm is a small one for carrying a private telephone wire, which will be connected with 52 telephones located at intervals on the poles, to be used by linemen.

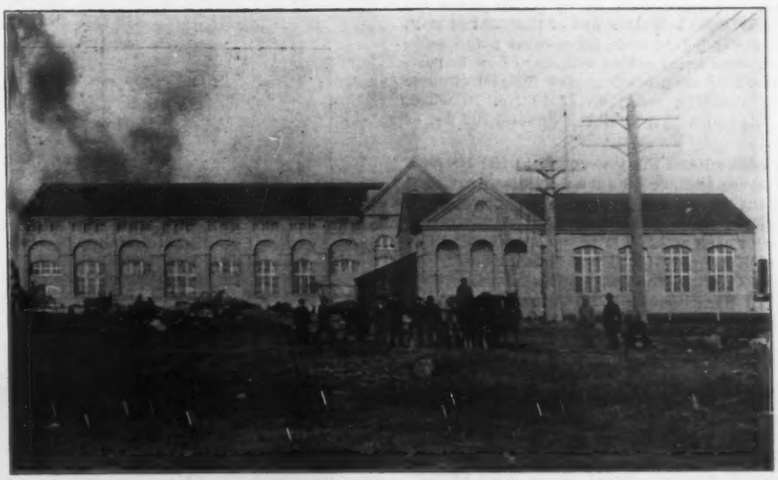


FIG. 3.—TRANSFORMER HOUSE AT THE NIAGARA END OF THE NIAGARA FALLS AND BUFFALO ELECTRIC POWER TRANSMISSION LINE. MAIN POWER HOUSE IN LEFT BACKGROUND.

The insulators weigh 9 lbs. each; they are double petticoated, having two deep annular grooves around the bottom to prevent water or ice from forming an electric connection between the wire and the insulator pins. A groove at the apex carries the wire. The insulator is provided with a gutter running to a point on either side to prevent icicles hanging in such a way as to strike the cross arm.

These insulators were tested to withstand a pressure of 40,000 volts. The test was made by inverting the insulator and partly immersing it in brine contained in a metal vessel. The pin hole was also filled with brine. The terminals of the high pressure current were connected with the metal vessel and with the brine in the pin hole of the insulator. No calibrating instruments were used in circuit, the eye alone being relied upon to detect the passing of current through or across the insulator. The insulators are furnished by the Imperial Porcelain Works, Trenton, N. J.

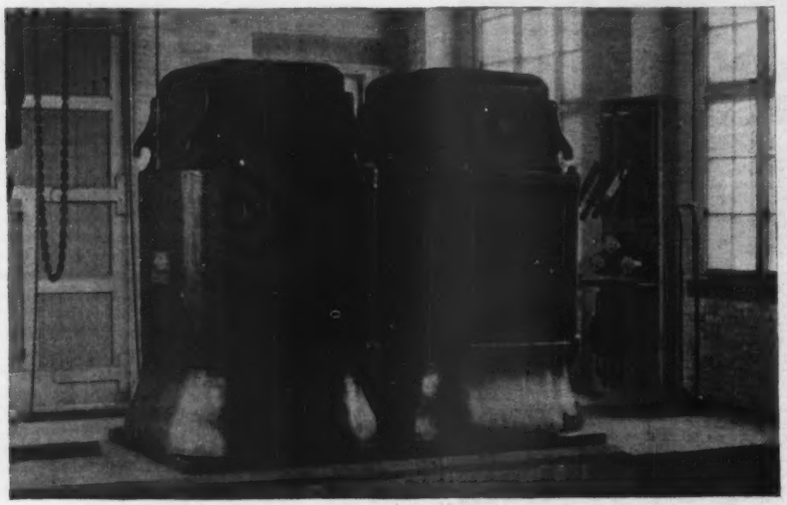


FIG. 4.—STEP-UP TRANSFORMERS, 1,250-H. P. CAPACITY EACH FOR NIAGARA FALLS AND BUFFALO ELECTRIC POWER TRANSMISSION.

General Electric Co., Schenectady, N. Y., Contractors.

In the rush of putting up the line some smaller size insulators were substituted and in several cases where this was done not only the pins but the cross arms have been burned off by the escaping current due to the insufficient insulation.

Looking from the Niagara end, the poles are set so that the outer ends of the cross arms are directly over the boundary line of the right of way; this leaves sufficient room for another pole line on the left. The three cables which are now in position are bare copper wire, each 350,000 circular mils in diameter, made up of 19 No. 10 wires. Each pole supports a weight of about 1,200 lbs. of copper.

The cables leave the generators in the Niagara power house and are conducted in a lead covering across the "Bridge of Sighs" to the transformer house. The step-up transformers are the largest in the world; each of 1,250 HP. capacity, 7 ft. 10 ins. high, with a base 64 × 56 ins. Each transformer weighs 25,000 lbs. The 2,200-volt alternating current from the generators is here raised to 11,000 volts, and changed from a two-phase to a three-phase current. Provision is made in these transformers, as well as in the ones at the Buffalo end, for raising the voltage to 22,000 volts whenever it is wished to increase the capacity of the line. The transformers are cooled by an air blast from a fan driven by a 5 HP. motor. From the transformers three cables pass to the high tension switchboard standing beside them. This switchboard is of marble, and carries three high tension switches, each switch being separated by a marble barrier about 1 in. thick. This partition prevents arcing from switch to switch. The switchboard also carries current indicators and three special fuse carriers. From the transformer house the wires pass through lightning arresters to the first pole of the pole line standing immediately in the rear of the building.

At Buffalo the cables pass from the last pole into a small brick terminal station (Fig. 6), where connection is made through lightning arresters with the underground cables. The lightning arresters are of the Wirt type, especially designed for heavy voltage transmission work, and are single pole. They consist of strips of marble, upon which are mounted eleven cylinders, giving one air gap space 1-32 in. for each one thousand volts, with an allowance of 25% rise in the potential. In the action of the arrester, the large metal cylinders serve to chill the arc, so that, on reversal of the current, the arc is extinguished, no dependence being placed upon any non-arcing property of the metal to put out the arc. In order to limit the current on short circuit, and thus the heating effect, a special solid graphite rod of low non-inductive resistance is used. The arresters are similar to those used on the Big Cottonwood transmission line at Salt Lake City, Utah, which have effectually protected the machinery in many severe storms. The underground wires are rubber covered, taped and sheathed with lead; the insulation was tested to withstand 80,000 volts. The vitrified clay conduit has 12 holes or ducts, each 3 ins. in diameter; but three of these ducts are in present use. The conduit is laid 18 ins. under ground and surrounded on all sides by a bed of concrete 4 ins. thick.

The step-down transformers (Fig. 7) are located in a small building adjoining the Buffalo Street Ry. power station. These transformers reduce the pressure from 10,700 to 370 volts; they are similar to the ones at the Niagara end, and, like them, are cooled by an air blast. The 370 volt current is conducted to three rotary transformers in the power house. Two of these are in use, and the third is held in reserve. These transformers are six-pole machines; they convert the 370-volt alternating current into a 500-volt direct current, in which form it is used on the Buffalo Street Ry. The rotary transformers are each 6 ft. 10 ins. high, with a base 36 × 47 ins., and weigh 7,000 lbs. The electrical apparatus has all been furnished by the General Electric Co.

We are indebted to the White-Crosby Co. and to the General Electric Co. for the information from which this article was prepared, and for our illustrations.

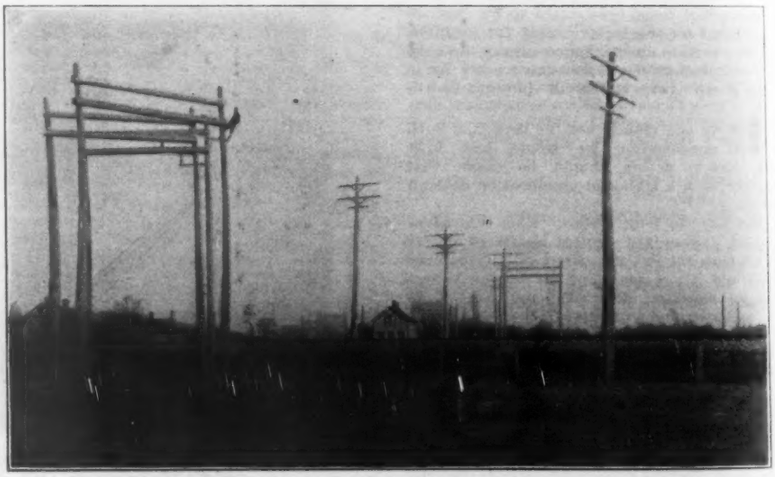


FIG. 5.—A PORTION OF THE POLE LINE FROM NIAGARA FALLS TO BUFFALO.

The White-Crosby Co., 29 Broadway, New York City, Contractors.

THE LATEST CAPE COD SHIP CANAL PROJECT has reached the time limit for depositing its $200,000 with the State Treasurer, as provided by the Massachusetts legislature. The law also provides that plans of location must be filed within six months from June 9, 1896. The preliminary plans have been prepared and approved by the joint board of railway and harbor and land commissioners, but they await the deposit with the State Treasurer before being presented to the Barnstable County Commissioners.

THE ERIE CANAL was closed to navigation on Dec. 1, and preparation is being actually made to enter upon the execution of the plans for the improvement of the State Canals, for which contracts have already been let, aggregating $4,000,000.

THE BOSTON PNEUMATIC TRANSIT CO., on Nov. 30, again received from the Board of Aldermen permission to lay and operate suitable underground pipes for transmitting mail matter, merchandise, etc., through certain streets of that city. Mayor Josiah Quincy, on Oct. 2, returned without his approval a similar order, stating that he believed that no such franchise should be granted without provision in it for a pecuniary return to the city. The present order is based upon an agreement of the company to the following effect: One year after the completion of any line of tubes the company is to pay one-half of one per cent. of the total gross revenue of the company for that year. For each year thereafter the company shall add one-quarter of one per cent., until at the end of the ninth year of its operation it shall pay to the city 2½% of the total gross receipts and continue to pay this sum so long as the tubes are operated. The contract provides that the conduits must be completed by Jan. 4, 1898, under the general supervision of the Superintendent of Streets. As this order conforms generally with the recommendations of the Mayor it will doubtless be approved.

A STEEL RAIL PLANT is projected for Japan. Five Japanese commissioners who are making a tour of the United States and Europe in search of information concerning steel making were in Pittsburg last week visiting the principal works in that city and vicinity. It is said to be their intention to purchase an 8-ton converter and modern machinery for a small steel plant. The commissioners expect to sail from New York for Liverpool on Dec. 12.

THE BRONX PARK BOTANICAL GARDEN PLANS, for New York, are not yet made public, but Prof. Britton, who is to be in charge, says that the general committee on plans has decided that the greater part of the $250,000 to be first raised for the improvement of the 250 acres, set apart in Bronx Park for the garden, will be expended upon the museum building, which is to be built upon elevated ground about 1,000 ft. east of the Bedford Park station of the Harlem Railway. This building will have a front of 304 ft., with two wings each 200 ft. long and 50 ft. deep. Houses for the director-in-chief and head and second gardener will be built east of the Bronx River, and there will also be propagating houses and rain-shelters. The plans provide for a second glass-house, larger than the one above described, to be located south of the Southern Boulevard. These plans are now being completed, and as soon as they have been passed upon by the Park Commission and the Building Department they will be published.

FIG. 7.—STEP-DOWN TRANSFORMERS AT BUFFALO FOR THE NIAGARA FALLS AND BUFFALO TRANSMISSION. General Electric Co., Schenectady, N. Y., Contractors.

THE U. S. GUNBOATS "VICKSBURG" AND "NEWport" were launched at Bath, Me., on Dec. 5. These are composite boats with steel frames planked below the water line and plated above. Each boat is barkentine rig, with three full decks. The lengths are 168 and 174 ft. on load water line, the extreme beam is 34 and 36 ft., the mean draft is 12 ft., displacement 1,000 tons, and speed 12 knots. The engines are twin-screw vertical triple expansion, with 800 I. HP. and 16, 22 and 36-in. cylinders and 24-in. stroke. The armament includes six 4-in. rapid-fire guns, and four 6-pdr. and two 1-pdr. rapid-fire guns. The crew will include 11 officers and 135 men for each.

THE BOARD OF INSPECTORS OF STEAM VESSELS at New York city is being investigated by a special board of inquiry appointed by Secretary Carlisle. It is charged that the inspectors of the local board have accepted bribes to pass vessels needing repairs.

VITRIFIED SEWER PIPE 36-INS. IN DIAMETER, to the extent of 3,000 ft., will be laid in Montpelier, Ind., in place of brick sewer usual for so large a sewer. The pipe will be made by the Blackmer & Post Pipe Co., of St. Louis, of which Mr. L. W. Post is Vice-President and General Manager.

THE POSTAL TELEGRAPH CABLE COMPANY, says the "Journal of Commerce," is to be purchased by the Commercial Cable Company, with the view of establishing a great foreign and domestic organization. The Commercial is to issue $20,000,000 in 500-year bonds and to exchange $15,000,000 of this, dollar for dollar, for the stock of the Postal Cable Company, with a guarantee of 4%; the balance will remain in the treasury of the Commercial Company and be added to its $10,000,000 of capital stock. The Commercial Cable Company is popularly known as the Mackay-Bennett Cable Co., and it owns three cables between Nova Scotia and Ireland, one from Ireland to Havre, and one from Ireland to Bristol, England; also one from Nova Scotia to New York and one to Brockport, Mass. The third cable to Ireland was completed in August, 1894. The president of the company is J. W. Mackay, and operations commenced in December, 1884. The gross earnings of 1895 were $2,000,738; with $1,215,298 net earnings.

A THIRD ST. LOUIS BRIDGE is being discussed for North St. Louis by the North St. Louis Improvement Association. Some railway officials are said to be interested, but as yet the project is talk only.

THE U. S. PATENT OFFICE, in the fiscal year ending June 30, 1896, received 41,660 applications for patents, 1,641 applications for designs, 2,460 caveats and 2,064 applications for trademarks. The patents granted numbered 22,791, and 11,466 patents expired in the year. The total receipts of the office amounted to $1,307,090, and $209,721 represented receipts over expenditures. The total balance to the credit of the Patent Office, in the U. S. Treasury, is $4,776,479.

THE VACANT PUBLIC LANDS of the United States, says Mr. Francis, Secretary of the Interior, in his annual report, amount to 600,000,000 acres not including Alaska. The actual public domain now amounts to 1,849,072,537 acres. The General Land Office has disposed of 946,000,000 acres up to 1896, with 326,000,000 acres of this granted since June 30, 1883. Since 1862, 162,892,132 acres have been entered under the Homestead Act of 1862. To land-grant railways 83,784,705 acres have been distributed and 1,945,045 acres have been patented to wagon roads. The total area of the four National parks is 3,272,960 acres, and the estimated area of all Indian reservations on the public domain is 84,418,562 acres, with 1,397,691 acers in military reservations. Mr. Francis thinks that 100,000,000 acres of the arid lands could be reclaimed by irrigation.

THE EXPORTS of manufactured goods from the United States for October surpass even the remarkable record for September of this year. The exports of this character advanced from $16,352,356, in September, 1895, to $21,684,734, in September, 1896. The figures for October show an advance from $18,778,817, in 1895, to $23,479,279 in 1896, the highest total for any month in the present fiscal year. The total for the four months, including October, is more than $87,500,000, and if the rate is continued the total of manufacturing exports for the fiscal year will be $263,000,000; the actual total will not fall below $250,000,000 for the year. At the latter rate the exports of this character will be $22,000,000 in excess of the total for any fiscal year on record, and $49,000,000 more than the record for any calender year. The manufacturing exports for 1896 will be 26.47% of the total exports, the highest proportion on record, that of 1895, being 23.14%. The total exports for all kinds for 1896 will be about $882,520,000, only exceeded by the $1,015,732,011 exports of 1892. For the ten months ending Oct. 31, the value of copper ingots exported was $22,004,000, and that of refined oil, $47,979,000, the gain in those two items for the ten months, over 1895, was a little more than $16,000,000. The actual gain in the export of manufactured articles for the same ten months was $60,000,000. The exports of electrical and scientific apparatus advanced from $1,351,460, in the corresponding ten months of 1894, to $2,234,064 in the ten months of 1896. The value of colored cotton exports, for the same period, advanced from $3,120,791, in 1894, to $3,441,670 in 1896; but the export of uncolored cottons advanced from $6,486,289 to $10,322,833 in 1896, and was nearly double that of 1895.

THE PACIFIC COMPANY is the name of a company organized in New York City and incorporated in Virginia with $20,000,000 capital, with the alleged purpose of developing coal mines and building railways in Peru. The officers and directors are as follows: President, Harry Keene; Secretary, R. W. Hawkesworth; Treasurer, Jacob Bertschmann. The directors are the three above named and Charles F. Dieterich, Charles Coudert, E. J. Jerzmanowski, Isaac Alzamora, John C. Barron, David S. Walton, Henry T. Scott, Jose M. Yrigoyen, Charles W. Mayer and Appleton D. Palmer. The company's New York offices are in the American Surety Building at No. 100 Broadway. Mr. Keene is President of the Equitable Gaslight Company.

A KITE CARRYING A TELEPHONE WIRE over obstructions was successfully experimented with by Mr. Wm. A. Eddy, of Bayonne, N. J., on Dec. 6. The wire was sustained by three large kites. A lantern was attached to the outer end of the wire, and when it reached a height of 500 ft. was lowered by being paid out through a pulley suspended from one of the kites. When it reached the earth ground connections were established at each end of the wire and both telephone and telegraph messages were sent through it. The obstructions which the wire passed over included three lines of trees, two roadways, a line of telegraph and one of telephone wires and a house. Signals were exchanged for over an hour, and the kites and wire were then drawn in.

DOORS OPENED BY ELECTRICITY when a person steps upon the wire door mat have been placed at the entrance of the new city market, at Springfield, Mass. An electric motor using a 110-volt current furnishes the power for winding up a coil spring and closing the door, and the circuit is broken by stepping upon the mat, releasing the spring which opens the door. The inventors are Oliver H. Hicks and Robertus F. Troy, of Chicago.

A BOILER COMPOUND or water purifier for locomotive and other boilers, which has thus far shown very favorable results in actual use, has been tested on the Cleveland, Cincinnati, Chicago & St. Louis and the Wisconsin & Michigan railways. The chemicals which enter into its composition are given as follows: Ba C_3 H_6 O_3, Ca C_3 H_6 O_3, Ba Cl_2, and Ca O H_2 O, but the relative proportions of each in the mixture are secret. As marketed the mixture is in the form of powder and is to be added to the water, either hot or cold, in the proportion of about ¼-lb. per 1,000 gallons. It is claimed to be non-corrosive and to have no injurious effects upon the packing, and, of course, to prevent scale and rust. The makers are Engle & Co., of Chicago, Ill.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

In our last week's issue we gave a report of this meeting down to Wednesday afternoon, Dec. 2. The list of members and guests present increased until the adjournment on Friday afternoon, when it numbered 538, making the meeting the largest probably that has ever been held by any engineering society in this country. On Wednesday evening a reception and conversazione was held at Sherry's. This was the only distinctively social event of the meeting. Thursday morning's session was devoted to the reading and discussion of papers. The first was entitled "Experimental Investigation of the Cutting of Bevel Gears with Rotary Cutters," by F. R. Jones and A. L. Goddard. The authors describe the operations required in cutting bevel gears with rotary cutters in a milling machine. The only uncertainty in these operations is that of revolving the blank from its original or central position through such an angle that the cutter shall pass through the pitch point of the larger end of a tooth, and at the same time cut just enough off the smaller end to allow the gear to mesh with its mates without further dressing of the teeth.

By a series of experiments with an apparatus which they designed for the purpose they determined the amount which the blank should be revolved for a number of different sizes and shapes of gears. The results are given in the paper and will be of interest to machinists and others concerned in the production of bevel gears.

The next paper was presented by Mr. J. A. Laird, and was entitled

"The Calibration of a Worthington Water Meter."

The meter tested was a Worthington made entirely of brass, for hot water, and bought for testing purposes. It

was used to measure the feed water during the two 30-day duty tests on the Allis engines at the Chain of Rocks pumping station, St. Louis.

The method of making the tests is described and illustrated. It consisted in delivering the water passing through the meter into two tanks supported on platform scales, each holding about 1,000 lbs. The errors of the meter for each day are as follows:

Computation of Meter Error.

Date	Jan. 18.	Jan. 19.	Jan. 20.	Jan. 21.
Per cent. of error	+ 1.6	+ 0.1	+ 1.4	— 0.5

Jan. 22.	Jan. 23.	Jan. 24.	Jan. 25.	Jan. 26.	Jan. 27.	Jan. 28.
— 1.1	— 1.6	— 1.67	— 1.3	— 1.4	— 1.2	— 0.5

Jan. 30.	Jan. 31.	Feb. 1.	Feb. 2.	Feb. 3.	Feb. 4.	Feb. 5.
— 1.8	— 1.5	— 1.9	— 0.9	— 1.0	— 1.2	— 1.7

Feb. 6.	Feb. 7.	Feb. 8.	Feb. 9.	Feb. 10.	Feb. 11.	Feb. 12.
— 1.2	— 1.6	— 1.0	— 1.0	— 1.2	— 1.8	— 2.0

Feb. 13.	Feb. 14.	Feb. 15.	Feb. 16.	Feb. 17.	Feb. 26.	Feb. 27.
— 2.1	— 2.1	— 1.7	— 1.3	— 1.1	+ 0.7	+ 0.2

Feb. 28.	Feb. 29.	Mar. 1.	Mar. 3.	Mar. 4.	Mar. 5.	Mar. 6.
+ 0.6	+ 0.1	— 0.6	+ 0.3	+ 0.5	+ 1.1	+ 0.7

Mar. 7.	Mar. 8.	Mar. 9.	Mar. 10.	Mar. 11.	Mar. 12.	Mar. 13.
+ 1.1	+ 1.1	— 1.1	+ 2.5	+ 1.1	+ 1.2	+ 1.8

Mar. 14.	Mar. 15.	Mar. 16.	Mar. 17.	Mar. 18.	Mar. 19.	Mar. 20.
+ 1.5	+ 1.2	+ 1.2	+ 1.3	+ 0.1	+ 0.3	— 0.2

Mar. 21.	Mar. 22.	Mar. 23.	Mar. 24.	Mar. 25.	Mar. 26.
— 0.2	— 1.3	— 0.7	— 0.6	— 0.7	— 0.9

"The Contraction and Deflection of Iron Castings," was the next paper read, and was by Mr. Francis Schumann, of the Tacony Iron & Metal Co. He described a method of calculating approximately the deflection of castings of different shapes which is caused by the unequal contraction of its several parts. We shall shortly publish an abstract of this paper. It is, as far as we know, the first attempt to predict by calculation based upon the known shrinkage of a test piece what will be the shrinkage of a large casting, and what will be the extent of the deformation produced by such shrinkage. The paper led to considerable discussion, some of the members taking exception to some of the author's statements. The discussion covered a wider range than that of the problems presented in the paper, and showed that the whole subject of cast iron and its vagaries is one of great interest to many members of the society. It is proposed to make "The Physics of Cast Iron" a special subject for papers and discussions at the meeting to be held in Hartford next spring. The following papers were then read and discussed briefly: "A 200-ft. Gantry Crane," by John W. Seaver; "Friction Horse Power in Factories," by C. H. Benjamin; "Washing of Bituminous Coal by the Luhrig Process," by J. V. Schaeffer. We print the second of these papers in this issue and the other two will be printed at an early date.

Thursday afternoon was left free to the members to visit industrial works or to otherwise employ their time as they saw fit. Many of them remained at the rooms "for social and professional chat," as it was expressed in the programme. On Thursday evening another session was held for the reading and discussion of papers. The first was by Mr. F. A. Halsey, on

"Some Special Forms of Mechanical Computers."

This paper described several forms of the special circular slide rules invented by Mr. Wm. Cox, of New York, several of which have been illustrated and described in Engineering News. We quote the following extract from the paper:

These computers are simple mechanical devices in the nature of special circular slide rules, designed for the solution of certain more or less complicated formulas, each computer solving but the one formula (or in some special cases two) to which it is adapted. They are in this respect unlike the ordinary slide rule, which is, in a sense, a universal instrument. On the other hand, the slide rule covers only operations involving multiplication, division, squares, and square roots and their combinations, while these instruments can be made to handle any powers or roots or trigonometrical functions. Problems involving more than four factors, when solved by the slide rule, must be attacked piecemeal, whereas the computers may be made to solve at once problems containing any number of factors.

They are provided with different logarithmic scales, similar to those on the slide rule, but with the important difference that each scale represents one definite factor in the formula, and is made sufficiently long to cover all probable values of that factor, so that positive quantities as 8, 80, 800, etc., are read off without chance of error, thus overcoming the slide rule difficulty of locating the decimal point.

The next paper was presented by Mr. M. P. Wood, of New York city, and was entitled

"Rustless Coatings for Iron and Steel."

This is the fourth paper which he has presented to the society on the same subject. The following is an abstract:

The reported case of the corrosion of the floor beams in the old New York "Times" building, occurring, as it were, almost under one's feet in the short interval of 35 years, and in the hereinafter reported case of one of six days appear to be an unanswerable argument of the dangers of using the oxide of iron in any form for the protection of metallic structure from corrosion.

This argument may be reinforced by the query, What is or what will be occurring to the metallic portions of the many sky-scrapers that are in process of erection in our own and other cities at the present time, under great dissimilarity as regards temperature, humidity and other climatic conditions, but of one characteristic sameness—viz., being sealed in solid masonry or other coverings beyond the ken of inspection?

Inspection of these buildings now in progress, as well as those lately erected, reveals possibly a slight improvement in general over the conditions apparent two years ago; but the improvement is a hollow mockery, and will bear fruit for repentance ere many years have passed. These structures, though more carefuly painted than those erected before, with more and heavier coatings of some kind of stuff called paint, do not appear in a single case to have received any attention or consideration as to the condition of the metallic surfaces before applying the protective coating beyond a possible sweep with a dirty broom to get rid of the rough dirt from the workshop yard, and a possible wipe with a piece of old sacking to remove the grease due to machining processes. Anything like a washing down of the parts with soda-ash or lye-water to remove the grease, and then pickling with weak acid to remove the mill scale, and a subsequent washing with lime water to neutralize the acid bath, warming the work before painting it, and care to apply the paint only on clear, bright days, when no sweating can occur, or applying the paint in warm paint-rooms; it is safe to say that not in a single case out of the many skeleton structures of our modern sky-scrapers can this be found to have been the procedure. Not only this, but in the minor parts of the structure, where the light grillage and ornamental partitions should at least claim these precautionary measures to be used, and where the question of weight and complexity of parts could not arise to cause a decision on the side of Cheap-John methods.

In previous papers on "Rustless Coatings" read before this society, attention has been called to a few of the many cases of destructive corrosion that are apparent to the most casual observer, viz.: The Niagara Falls and Brooklyn Suspension Bridges (Transactions A. S. M. E., Volume XV., pp. 1044-1040); the Victoria Tubular Bridge across the St. Lawrence River at Montreal, Can. (Volume XVI., p. 410), and the Firth of Forth Cantilever Bridge, Scotland (Volume XVI., p. 407); the elevated railway and viaduct constructions of the Metropolitan Railway lines in the city of New York, and the evidently wrong conception from the beginning of what was necessary for the protection from corrosion of these costly structures, so that their life could be measured by the lapse of centuries instead of decades.

"Engineering," July 31, 1896, pp. 157-158, reports from a paper read by Mr. Hector Macoll, of Belfast, before the Institute of Mechanical Engineers (before referred to) an interesting case of the Unusual Corrosion of Marine Machinery due to the presence of oxide of iron pigment.

On Dec. 24, 1895, the steamer, "Glenarm," carrying a cargo of about 650 tons of "burnt ore," struck on a rock in the Sound of Mull, and was at once beached in Scallaster Bay, where the sea stood a little over her after-deck, at low water, and close up to her bridge deck at high water. After having been submerged six days, she was pumped out and raised. On examination the machinery was found to present an extraordinary appearance; all wrought-iron work was deeply and roughly corroded, and planed cast-iron work rendered so soft as to be easily cut with a knife. These unusual effects were undoubtedly caused by the cargo of "burnt ore." Every 100 tons of cargo contained as much sulphate of copper as would, if available, dissolve nearly 32 cwt. of metallic iron. The burnt ore might also contain a small quantity of free sulphuric acid, which would combine with the soda of common salt in the sea-water and set free hydrochloric acid, and the latter would rapidly act upon copper or brass.

On the condition of affairs being discovered, the engines and boilers as well as the hull were at once opened up for survey. The general condition of the engines was that wrought-iron work had been penetrated by corrosion to a depth of about 3 32-in., and planed cast-iron so softened that ⅛ in. had to be taken off before a hard surface was regained. Surfaces in bearing contact, or with oil between them, and all painted surfaces, were completely preserved.

The condition of both boilers looked serious. The front end plate of the main boiler was considerably wasted; the furnaces, which are of the spiral, corrugated type, had corrosive scores running in the direction of the corrugations; and the tubes were covered with a deposit of what appeared to be pure metallic copper. In the end, however, after careful drilling and gaging, it was found that an unexhausted margin remained in all except the tubes. These were all found to be seriously corroded in both boilers, and every tube was therefore cut out and renewed; after which the boilers were satisfactorily tested.

The cause and effect are so closely related that all doubts as to the cause are set at rest. As stated in previous papers read before this society, the corrosive agent is found in the oxide of iron pigment as usually prepared for the market, and claiming great superiority as to quality by reason of its bright attractive color and purity over other forms of oxide pigments ground from hematite ores, whose dirty brown purplish color indicates the presence of more or less clay and earthy matters, wholly unreliable as a pigment even when mixed with good linseed oil, and whose varying qualities are readily detected in the separate consignments from the same manufacturer or compared with each other. Of the samples from the many concerns turning out this Cheap John material, none are good, all are bad and comparatively useless for the protection of metal, however admirably adapted by virtue of their cheapness to wooden structures, and are a poor investment for them if the merits of a better paint is considered.

How much damage is done to the internal parts of a marine vessel by the use of iron oxide paints with which those portions below water-mark in the holds are usually coated it is hard to realize. Bilge-water is a very corrosive fluid, composed as it is of sea-water mixed with the leakage from fluid cargoes soured by the heat of the hold, the sulphur-water from the furnace, ashes and pyrites in the coal bunkers, mill-scale and paint oxides of copper and iron thrown down in the course of repairs to boilers and hull and seldom if ever removed, continually agitated and washed over the exposed metallic surfaces, and aided by the presence of carbonic acid generated from the conglomerate mass in the confined air of the hold. It is scarcely to be wondered at that the vessel when in the dry dock for the too often extended yearly examination is found in such an advanced stage of corrosion that it is necessary to cut out and renew frames, bulkheads, and other parts so corroded as to endanger the safety of the ship in seaway.

In the discussion which followed the paper some of the speakers showed that their opinions differed from that of the author concerning the value of oxide of iron as a pigment. It was also shown that iron wires taken from suspension bridges after 40 years' service had shown no corrosion if they were properly protected. Dr. C. E. Emery related cases of protection of the inner shells of steamships from corrosion by bilge water for more than 30 years. His remedy is paint, plenty of it, and often repeated. The best painting of the inside of the hull of a vessel is done by a laborer who thinks nothing of the economy of paint, but "daubs it on," and the worst by a skilled painter, whose training has been in the direction of making a can of paint go as far as possible.

The next paper was "A Method of Shop Accounting to Determine Cost," by Mr. H. M. Lane. We shall print this paper in full in an early issue.

It was followed by a lecture by Mr. Harry de B. Parsons, member of the society's committee on Tests of Fire-Proofing Material, on the tests which have been made to date by the committee. It was illustrated by a number of lantern slides. The lecture covered the results given in the committee's preliminary report, which was printed in full in our issue of Aug. 6.

The closing session was held on Friday morning, and was devoted to the reading and discussion of papers. The first was by W. W. Christie, on

"The Efficiency of the Boiler Grate."

The author compiled the result of 108 boiler tests, selected from various sources, and by plotting the relation of the economy to the rate of combustion per square foot of grate surface, arrived at the conclusion that the rate of combustion which gave the highest economy was 13 lbs. per sq. ft. of grate per hour for anthracite, and 23.8 lbs. for bituminous coal. This conclusion was disputed by those who took part in the discussion, and one member showed that a correct plotting of the data given in the paper led to the conclusion that within the limits of 5 and 37 lbs. per sq. ft. of grate the economy was entirely independent of the rate of combustion. This corresponds with what was stated in our editorial on Sept. 24, 1896, showing that in locomotive boilers, between the limits of 60 and 240 lbs. per sq. ft. of grate per hour, the efficiency is independent of the rate of combustion, providing the area of grate is cut down in proportion to the increase of grate, except in so far as at the higher rates of combustion a greater quantity of unburned coal is discharged out of the stack.

The next paper was by Mr. R. S. Hale, of Boston, entitled

"Efficiency of Boiler-Heating Surface."

It was a study of formulas given by Rankine, Isherwood, Clark, Emery and Carpenter, to express the relation between the extent of heating surface and the economy of a boiler, the rate of combustion being taken as constant. By plotting these several formulas, the pounds of water evaporated per pound of combustible being taken as ordinates and pounds of water evaporated per square foot of heating surface per hour as abscissas, it was shown that wide differences existed in the formulas. The author then discussed the effect of radiation upon the economy and plotted a series of curves showing this effect. The results of Mr. Barrus's tests with anthracite coal, taken from his book on "Boiler Tests," were then plotted, and it was shown that while a curve could be drawn representing an average relation of the economy to the rate of evaporation, yet results of the individual tests were very far from this average. The discussion which followed the paper was quite lively, and when printed together with the paper as finally revised for the "Transactions," will probably prove an important contribution to our knowledge on the subject of the paper, or at least it will show how great is our ignorance of the subject and how much remains to be learned concerning it.

The next papers on the list were: "Paper Friction Wheels," by Prof. W. F. M. Goss, and "Steam Engine Governors," by Mr. Frank H. Ball. The first of these papers will be printed in our columns in full, and the second in abstract, at an early date.

These papers were followed by a brief presentation in abstract of a paper of 96 pages entitled "The Metric versus the Duodecimal System," by Mr. George W. Colles. The paper is the most extended and vigorous attack upon the metric system of weights and measures which has appeared in many years. It is divided into two parts: 1, Historical; 2, Argumentative. The title is rather unfortunate, as the author uses the word Duodecimal as meaning the ordinary English system of measures in which the foot and inch are the primary units, while the same word is used by other writers to mean the proposed new system of numerical notation, based upon twelve digits instead of ten. The discussion which followed the presentation of the paper was nearly all in its favor, but a few members pointed out what they considered errors in some its minor statements. The sentiment of the members of the society in general is strongly against the metric system, and especially against compulsory legislation for its introduction. The sentiment of the Council has been shown, as was stated in our last week's issue, by its appointment of a committee to prepare material to be used in opposition to the proposed Congressional legislation to make the metric system compulsory.

The next and last paper was entitled "Aluminum Bronze Seamless Tubing," by Mr. Leonard Waldo. This tubing is an entirely new production of the Pope Tube Co. Samples of various sizes were shown. We shall print an abstract of this paper at an early date.